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Racial Disparities in Cancer Care | Access to Care for Transgender Veterans | Hepatitis C Among US Veterans | Battling Tobacco Use at Home | HEALTH EQUITY | How Might the Provision of Culturally Competent Services Be Enhanced for American Indian and Alaska Native Veterans? | Improving Trends in Gender Disparities | Suicidality Among Hispanic and African American Veterans Following Surgery

APHA

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COVER: A demonstrator plays a drum at an Enbridge Inc. Line 3 construction site during a "Treaty People Gathering" protest in Clearwater County, MN, on Monday, June 7, 2021. Environmental and tribal groups say Enbridge Energy's plan to rebuild Line 3, which would carry Canadian tar sands oil and regular crude, would worsen climate change and risk spills in sensitive areas where Native Americans harvest wild rice, hunt, fish, gather medicinal plants, and claim treaty rights, reports the Associated Press.
Cover concept and selection by Aleisha Kropf. Photo by Nicole Neri/Bloomberg via Getty Images. Printed with permission.

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Ten Public Health Tips to Heal From COVID-19 Losses

Over the past 20 months, we have all been bombarded with information about COVID-19. From professional journals to Facebook, it has been nearly impossible to stay away from data for more than a few minutes. Every conversation with family and friends, every news report, every work-related policy, every travel plan, and every wedding invitation and dinner plan have had at least a few minutes of discussion about COVID-19. Truth and lies have comingled in ways that I had not seen before in my life. Nor had I ever thought carefully about politics as another determinant of health.

But, as president of the American Public Health Association (APHA), I've had the opportunity over the past year to hear from people around the country about their stories and about how they are coping with this pandemic. I have heard from colleagues who remained determined to do the right thing for the health of their communities, even when their employment was in jeopardy and they and their families received threats. I have heard from some friends and relatives who think that this is all a big hoax and that I should really read this or that thing their friend posted on Twitter. I have been moved to tears by the dedication of so many, and I have been—and remain—incensed at the intentional disinformation campaigns.

I've read about the impact on the economy, on the health sector, on educational achievement, and on the food chain, to name a few. But the report that struck me the most was one that stated that, on average, every person who dies from COVID-19 leaves behind nine mourners. This means there are almost 42 million people in the world mourning the loss of a loved one, 6 million of those in the United States.

I try to grasp the impact of this pandemic on the emotional well-being of the world I live in. Besides everything else, how do we come back from this pain? How do we heal from these losses and attempt to return to some semblance of normalcy in our everyday lives? How do we heal the social wounds that have been inflicted on this nation by a false narrative that has only fostered a longer agony? I am no thanatologist but can offer some thoughts about what I'm doing in this regard.

First, I acknowledge the losses and build healing spaces for individuals and communities to mourn in their own ways.

Second, I redouble my efforts to remove the structural inequities that foster the uneven distribution of the burden of disease.

Third, I recommit to redressing the pervasive racist practices that continue to keep historically marginalized communities out of the rooms where decisions are made.

Fourth, I look back and examine how we have managed the situation, what we did right, and what we did wrong.

Fifth, I continue to advocate adequate funding for the public health infrastructure and emergency preparedness systems.

Sixth, I amplify my work in the realm of civic engagement and voter registration to ensure that every voice is heard.

Seventh, I work to strengthen our ability to respond quickly and assertively to disinformation campaigns.

Eighth, I seek to partner with key players outside our field to better understand the issues and to help us extend our reach.

Ninth, I renew my efforts to develop a health workforce that mirrors the population it serves.

Tenth, I don't forget to allow myself to laugh, to weep, and to take a break.

It's been an honor to be the "virtual president" of the APHA.

José Ramón Fernández-Peña, MD, MPA
APHA President

DOI: https://doi.org/10.2105/AJPH.2021.306596

12 Years Ago

Racial and Socioeconomic Disparities in Residential Proximity to Polluting Industrial Facilities

Lower-income people were found to be significantly more likely than were higher-income people to live near a polluting industrial facility. Similarly, those without high school diplomas were significantly more likely to live near such a facility than were those with higher levels of education. Although we did not find significant gender differences in regard to proximity to a facility, our results suggest that marital status is correlated with the presence of nearby polluting industrial facilities. Participants who were divorced or separated or had never been married were more likely than were participants who were married or widowed to live near such a facility, but at levels not quite reaching statistical significance. . . . Racial disparities were also much more pronounced in certain areas of the country than in others.

From AJPH, *Supplement 3, 2009, p. S654*

17 Years Ago

Cumulative Environmental Risks Among Low- and Middle-Income Children

Environmental risks are not randomly distributed in the population; instead, they are inversely correlated to income. Economically disadvantaged children live in noisier and more crowded homes and are exposed to more environmental toxins than their middle-income counterparts. Housing quality is also inversely related to income. Ethnic minorities also suffer disproportionate environmental risk. . . . Although poor children are substantially more likely to confront singular environmental risks in their immediate environments, exposure to cumulative environmental risks may be a particularly important and unstudied aspect of environmental justice and health. If the ecology of childhood poverty is characterized by the confluence of environmental risks, examination of the health consequences of singular risks may underestimate the true environmental risk profile of low-income children.

From AJPH, *November 2004, p. 1942*

Environmental Factors Affecting Prevention of Schistosomiasis Infection

Kenya is among the countries with the greatest prevalence of schistosomiasis, a neglected tropical disease caused by flukes and transmitted through contaminated water. Mwai et al. aimed to determine whether environmental factors affect the burden of disease caused by schistosomiasis. Using multistage sampling, Mwai et al. surveyed 465 households to investigate environmental factors and schistosomiasis infection in Mwea Sub County. Households were significantly more likely to report schistosomiasis infection (n = 436; 93.8%) during the rainy season ($P \leq .001$). Water sources were also significant when considering schistosomiasis infection, with most households obtaining water from canals (n = 340; 73.1%) and rivers (n = 326; 70.1%). The authors conclude that flood mitigation strategies in high-risk areas should be implemented to prevent schistosomiasis infection during the rainy seasons and recommend construction of safe water sources.

Citation. Mwai J, Oduor Omogi J, Abdi MH. Environmental factors influencing prevention and control of schistosomiasis infection in Mwea, Kirinyaga County Kenya: a cross sectional study. *East Afr Health Res J*. 2021;5(1):99–105. https://doi.org/10.24248/eahrj.v5i1.657

Unintended Consequences of Charging for Clean Air Zones

The UK government is asking local authorities to consider imposing a daily charge on polluting vehicles entering “clean air zones” as part of their plan to improve air quality. Using qualitative methods, Rashid et al. explored the unintended consequences of such a policy on people living in multiethnic areas in Bradford, UK. Through 10 focus groups with 87 people, air pollution was not considered the most relevant environmental pollutant in the community and that many believed that low-income families did not have the resources to purchase less-polluting vehicles or to pay the daily charges, placing a disproportionate burden on them. The authors concluded that careful engagement and communication will be needed to ensure acceptance of such policy interventions.

Citation. Rashid R, Chong F, Islam S, Bryant M, McEachan RRC. Taking a deep breath: a qualitative study exploring acceptability and perceived unintended consequences of charging clean air zones and air quality improvement initiatives amongst low-income, multi-ethnic communities in Bradford, UK. *BMC Public Health*. 2021;21(1):1305. https://doi.org/10.1186/s12889-021-11337-z

Accounting for Environmental Justice in Evaluating Scenarios for Land Use

Cost–benefit analyses are commonly used to help make decisions regarding land use; such analyses reduce all aspects of an issue to a monetary value based on assumptions that raise ethical concerns. Zepharovich et al. instead used a social multicriteria evaluation of deforestation in the Argentinean Chaco. They considered multiple scenarios that incorporated the stakeholders’ needs and interests. Zepharovich et al. considered environmental, social, cultural, and economic costs of deforestation as well as environmental justice. The scenario that indigenous individuals suggested was the most sustainable and addressed issues in distribution, recognition, and procedure. The authors concluded that a new framework for accounting for inequity in environmental decision-making was needed.

Citation. Zepharovich E, Graziano Ceddia M, Ristab S. Social multi-criteria evaluation of land-use scenarios in the Chaco Salteño: complementing the three-pillar sustainability approach with environmental justice. *Land Use Policy*. 2021;101:105175. https://doi.org/10.1016/j.landusepol.2020.105175

How Prepared Are Israeli Health Care Professionals to Manage Heat Stroke in Children?

Heat stroke is a life-threatening condition among children, and rapid-cooling treatment remains the most important intervention in emergency settings. Cohen-Ronen et al. surveyed all health care workers in Israel’s pediatric emergency departments to assess correct heat stroke management practices. Of the participants, 30% reported ever treating exertional heat stroke. This type of heat stroke follows most commonly from motor vehicle–related child hyperthermia and exertional heat stroke; only 60% of the former and 40% of the latter was correctly treated with rapid-cooling treatment. Certificated pediatric emergency medicine physicians answered significantly more correctly on the management for both conditions. This study highlights the gap in knowledge among Israel’s health care workers on how to correctly treat patients suffering from heat stroke.

Citation. Cohen-Ronen N, Rimon A, Cohen N, Capua T. Heat stroke: knowledge and practices of medical professionals in pediatric emergency medicine departments—a survey study. *Isr J Health Policy Res*. 2021;10(1):35. https://doi.org//10.1186/s13584-021-00469-7

Prepared by Vrinda Kalia, Ahlam K. Abuawad, Megan E. Marziali, and Luis E. Segura, Columbia University, New York, NY. Correspondence should be sent to the AJPH Global News Team at les2196@cumc.columbia.edu.

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Time to Address Inequities in Chlamydia Screening Among Adolescents

Michelle L. Pickett, MD, MS, Monika K. Goyal, MD, MSCE, and
Lauren S. Chernick, MD, MS

ABOUT THE AUTHORS

Michelle L. Pickett is with the Department of Pediatrics, Medical College of Wisconsin, Milwaukee. Monika K. Goyal is with the Department of Pediatrics and Emergency Medicine, Children's National Hospital, George Washington University, Washington, DC. Lauren S. Chernick is with the Department of Emergency Medicine, Columbia University Irving Medical Center, New York, NY.

See also Wood et al., p. 135.

In the United States, chlamydia rates have reached an all-time high, with Black and indigenous people of color disproportionately affected.[1] According to 2019 data from the Centers for Disease Control and Prevention (CDC), rates of all sexually transmitted infections were one to two times higher among Hispanic or Latino people; three to five times higher among American Indian/Alaska Native, Native Hawaiian, and other Pacific Islander people; and five to eight times higher among Black or African Americans than among non-Hispanic Whites.[1] Specifically, the reported chlamydia rate among Black adolescents 15 to 19 years of age was more than six times the rate reported among White adolescents of the same age.[1]

Differential access to and provision of health care services can lead to worse health outcomes, perpetuate bias and stigma, and oppress marginalized populations. This is why one of the overarching goals of Healthy People 2030 is to eliminate health disparities and attain health equity for all.[2] The most recent Youth Risk Behavior Survey did not reveal racial/ethnic differences in the proportion of students reporting sexual activity.[3] The CDC recommends annual screening for chlamydia among all sexually active females younger than 25 years.[4] Thus, sexually transmitted infection screening rates should be relatively similar among Black and White female adolescents.

Yet, in this issue of *AJPH,* Wood et al. (p. 135) found that chlamydia screening rates were higher among Black females than White females and that individual clinicians were more likely to screen Black patients than non-Black patients. Wood et al. surmised that implicit bias among clinicians may be driving such differential practices but did not directly explore the role of implicit bias in physician behavior. Nevertheless, data from this retrospective cohort study of 15- to 19-year-old females across 31 pediatric primary care clinics prompted us to further explore what factors may be driving these disparate rates, implicit bias being one of many. Quite simply, the more screening is done, the more infection will be found. If clinicians are inherently screening Black adolescents more, there will likely be more infection found.

An argument could be made that clinicians may screen more Black females because they deem them more "at risk" given epidemiological data demonstrating greater rates in that population. But which came first? Are sexually transmitted infection rates higher in Black populations because of a multitude of socioeconomic reasons, or is it clinician bias (which has been well reported[5]) that has led to increased testing that subsequently reveals higher rates among Black people, further perpetuating the disparity? In all likelihood, it is a combination of both.

As growing data reveal differential treatment of patients according to their race and ethnicity, many of us are working to develop interventions to achieve health equity. One such method is a standardized or automated approach to screening, such as universal screening for all sexually active adolescents. If universal screening is to be successful, however, patients must identify themselves as sexually active and agree to be screened. Literature has shown that sexual history is often not documented during pediatric primary care visits.[6] Thus, universal screening of the sexually active population is moot if clinicians do not document a sexual history in the first place.

A standardized method to collect sexual history data that does not rely on physician inquiry is a useful, nonjudgmental, and efficient process for obtaining such information from adolescent patients. If successfully operationalized, a method of this nature, such as self-reported sexual histories collected via electronic questionnaires with automatic screening for sexually active individuals, regardless of race or ethnicity, could help lessen disparities.

One way to increase screening efforts is to expand screening venues. Many adolescents do not see their primary care physician annually, and Black and indigenous people of color have less access than White people to primary care and preventive services.[7] Expanding annual screening beyond the primary care office and bringing screening to areas frequented by adolescents can help reach high-risk groups and mitigate disparities. School-[8] or sport-based screening, at-home screening, and mobile neighborhood screening are nontraditional venues that may increase screening access for marginalized adolescents. Emergency departments, in particular, serve as a source of health care access for Black and indigenous people of color and marginalized groups[9] and thus may be a strategic venue to offer screening for sexually transmitted infections. These expanded screening opportunities should be offered at no cost to eliminate another barrier.

Although the suggestions offered here may increase screening, they fail to fully address an underlying problem: Black patients' mistrust of the health care system.[10] This mistrust is present because of many historical and current issues facing our country, not only in health care but politically and socially, including but not limited to slavery, past laws banning interracial marriage based on biological concerns regarding racial mixing, the Tuskegee syphilis trial, and police brutality. Especially with respect to sexual health, patients need to feel safe and comfortable in discussing highly personal information. Although there are actions we as health care providers and public health educators can engage in (e.g., undergoing implicit bias training as suggested by Wood et al.), there are deeper rooted systemic issues outside of medicine that, either intentionally or not, hurt people of color and continue to perpetuate disparities, adding to mistrust of the system.

Even if health care systems mandate training to reduce bias, stigma, and microaggression among providers, medicine is not practiced in a silo. There needs to be meaningful change in society if we want to eliminate disparities. Practices such as redlining, poor funding for schools in Black neighborhoods, and voter suppression laws are all intended to oppress Black and indigenous people of color. These factors, along with historic medical experimentation among Black people without consent, led to mistrust of the system, including health care. Even recent laws such as the Texas abortion restriction law will disproportionally hurt women of color because they are less likely than White women to have the means to travel outside of the state for a safe, legal abortion.[11] To decrease health care disparities, including those demonstrated by Wood et al., we must advocate for our patients and use our votes to support policies that lead to racial equity in health care and beyond. AJPH

CORRESPONDENCE

Correspondence should be sent to Michelle L. Pickett, MD, MS, 999 N 92nd St, Suite 550, Milwaukee, WI 53226 (e-mail: mpickett@mcw.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

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Work as a Root Cause of Home Health Workers' Poor Health

Sherry L. Baron, MD, MPH, Emma K. Tsui, PhD, MPH, and Margaret M. Quinn, ScD, CIH

ABOUT THE AUTHORS

Sherry L. Baron is with the Barry Commoner Center for Health and the Environment, Queens College, City University of New York, Queens, NY. Emma K. Tsui is with the City University of New York Graduate School of Public Health and Health Policy, New York, NY. Margaret M. Quinn is with the Safe Home Care Project, Lowell Center for Sustainable Production, and the Department of Public Health, University of Massachusetts Lowell.

In the December issue of *AJPH*, Sterling et al. report on data from the Behavioral Risk Factor Surveillance System highlighting the physical and mental health burden borne by home health workers (HHWs), defined in their study as home health and personal care aides.[1] They were able to accomplish this important work because information on industry and occupation was available for the subset of data they used. Their analysis showed that HHWs' levels of self-reported mental and physical ill health were higher than those of other aides and health care support workers who provide care in institutional settings. Creating options for elderly and disabled individuals to remain living independently at home is an important public health objective; the Sterling et al. findings[1] and others call attention to the importance of creating good-quality jobs as a necessary component of good-quality in-home care.

Aides in homes and institutions are essential workers and are predominantly female, low-wage immigrants and workers of color.[2] Although the care tasks performed by aides in the two settings are similar, the social, economic, and environmental organization of home care differs substantially from institution-based care.[2,3] To understand what drives greater ill health among HHWs, it is important to examine how work is organized in the home care industry and the risks that arise when the workplace is a private home. Unpacking "work" as a determinant of health is essential for the development of effective public health interventions.

An extensive literature describes fragmentation in the home care industry,[2] which manifests in a wide range of state-specific policy models and organizations financing and providing home care. This literature also describes aides' persistent low wages, driven largely by the limited reimbursement rates set by the Centers for Medicare & Medicaid Services.[2] Less well understood, however, is the origin of these low wages, which are rooted in racist policies and structures that drive many health inequities.[3] The Fair Labor Standards Act of 1938, a cornerstone of the "New Deal," was designed to protect workers through a minimum wage and other benefits. However, politicians from southern states refused to support a law that required Blacks doing the same job as Whites to earn the same wages.

The compromise allowing passage of the Fair Labor Standards Act was to exempt jobs typically held by Blacks from labor protections. An example is domestic service, the main occupation of Black women. In 1974, Congress revised the Fair Labor Standards Act to expand coverage to domestic service workers. One year later, however, the Department of Labor reinterpreted the 1974 amendment to exempt HHWs, including employees of for-profit businesses, by reclassifying them as companions (similar to babysitters). This amendment, known as the "companionship rule," remained until the US Supreme Court overturned it in 2015, finally requiring HHWs to be paid the federal minimum wage.

Although no longer sanctioned by federal law, home care work continues to be viewed by many as akin to babysitting, with significant consequences for HHWs' conditions of work.[3] HHWs are frequently hired part time on an hourly basis with inconsistent hours and timetables, including overnight work for which they may not be fully compensated. Many HHWs have no employment benefits such as paid sick or family leave or vacation time. Moreover, as Sterling et al. found,[1] they have limited access to health care.[2]

These labor policies and working conditions produce a range of occupational hazards and health outcomes that have been previously described and are summarized in Box 1.[3–10] However, less well studied are the complex and urgent mental health hazards of home health work, which are strikingly highlighted by Sterling et al.[1] HHWs value the intrinsic rewards and meaning of their relationships with clients; however, these same

BOX 1— Examples of Work-Related Hazards Associated With Home Care Work

Hazard Class	Home Care Hazard Examples
Biomechanical/Ergonomic	• Lifting/transferring/mobilizing clients • Moving equipment/furniture • House cleaning tasks • Laundry
Chemical	• Cleaning and disinfecting agents • Pesticides • Second-hand smoke from client or others in household (cigarettes, cannabis, vaping)
Biological	• Bloodborne pathogens • Respiratory and other infection hazards • Pests (bed bugs, dust mites, cockroaches, mice, rats)
Safety	• Slip/trip/fall hazards inside and outside the home • Unsafe neighborhoods • Car accidents, travel-related injuries • Unrestrained, aggressive pets • Client smoking during portable oxygen use • Improperly stored or disposed sharp medical devices (needles, lancets) • Unsafe electrical/gas connections
Psychosocial	• Working in isolation, no on-site work support • Relational stressors involving clients, their families, or aides' families • Physical and verbal aggression/abuse • Client death • Lack of respect and social recognition • Unpredictable work schedules, part-time work, low pay, limited benefits
Physical	• Heat stress as a result of inadequate cooling • Urban noise pollution

Note. Some hazards are unique to home care (relative to institution-based care); others present specific challenges because home care aides work alone.

relationships, as well as those with clients' families, can also result in a wide array of challenging emotional demands. Stressors include being asked to do tasks outside of one's job duties; clients' personalities, dementia, and mental health issues; dysfunctional dynamics in a client's family; aides' work–family conflicts; and client deaths.[4–9] Notably, verbal abuse and physical abuse are regular occurrences in these relationships,[10] and, in the home work environment, aides navigate all hazards alone.

The lived experience related to home care labor layers further stress on top of these day-to-day emotional demands. The case of client death—a common feature of home care work—is particularly illustrative. Client death can create grief symptoms among HHWs as well as a range of emotional responses. A client's death also leads to a loss of work. In some situations, the emotional impact of the death can result in aides being out of work for longer than they would want, further amplifying financial stress.[8] Across diverse worker populations, unpredictable work schedules are associated with multiple forms of psychological distress, and poverty is a well-known cause of poor mental health.[11] Finally, because of our societal devaluation of care work, some aides experience a long-term, wearing dissonance between the felt importance of their work and its low societal recognition.[5,7]

These poor conditions and hazards of work disrupt the lives of HHWs and result in high turnover in the industry overall. High turnover makes it difficult to train the workforce, including in terms of safety. Economic and work organizational factors represent health risks in themselves and intensify the risks from specific job hazards. They also are structural obstacles to professionalizing the workforce even as the need for more workers with more training and ability to deliver more specialized services becomes increasingly urgent as our population ages rapidly.[2,3]

Ongoing studies that document the burden and specific work-related determinants of health are important, but we already have enough data to take action, especially to meet HHWs' training needs and to provide improved job-based support.[12,13] Intervention efficacy studies need to further explore multilevel approaches that ensure decent wages and work hours, opportunities for job advancement, and reductions in work-related hazards.

Congress is currently debating a massive infrastructure bill that could include President Biden's proposed American Jobs Plan, which would expand funding for home care while improving workers' wages and working hours. If the bill is passed, adequate enforcement of labor standards will be essential. Implementation research can improve dissemination of programs, including through HHW unions, home care agencies, worker and elder advocacy and service organizations, and other community-based public health programs. It will be challenging to reach many HHWs with intervention programs owing to the large number of workers who are employed by small agencies or individual families, and therefore the role of labor unions, worker centers, and community-based medical and public health providers in disseminating programs will also be vital.

The work of Sterling et al.[1] and the context presented here point to important directions for future public health research. These insights into health inequities among HHWs were possible only because the Behavioral Risk Factor Surveillance System data set included information on respondents' industry and occupation. However, many national surveillance systems and population-based medical investigations do not capture participants' industry and occupation, let alone other dimensions of work that determine health. The absence of such measures contributes to poor recognition of the influence of work on health and of important employment-related pathways for improving structural health inequities. An essential first step is to embrace the critical role that good-quality employment can play in addressing structural barriers to good health and equity. AJPH

CORRESPONDENCE

Correspondence should be sent to Sherry L. Baron, MD, MPH, Barry Commoner Center for Health and the Environment, Remsen 311, Queens College 65-30 Kissena Blvd, Queens, NY 11367-1597 (e-mail: sherry.baron@qc.cuny.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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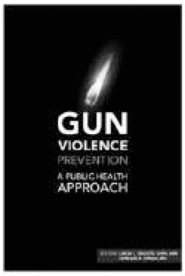

Supporting Local Public Health Departments: A Public Health of Consequence, January 2022

Farzana Kapadia, PhD, MPH

ABOUT THE AUTHOR

The author is the deputy editor of AJPH *and is with the School of Global Public Health, New York University, New York, NY.*

See also Jain et al., p. 24, Porter et al., p. 29, and Johnson et al., p. 43.

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The COVID-19 pandemic, one of the most significant public health challenges to face this generation, has not only exposed but substantially sharpened the fault lines in our social, economic, and political systems. Most alarming, these cracks have weakened our federal, state, and local public health institutions and agencies in ways that will undoubtedly impair their ability to positively affect the health of our populations. As we begin emerging from the pandemic and take stock of its impact on our communities and public health institutions, the articles in this month's issue of *AJPH* remind us of the work that public health agencies have been doing to understand the true burden of COVID-19 and mitigate its toll in local communities. Against such achievements, these articles also stress that lack of widespread public and political support, underfunding, staff turnover, and staff shortages at local health departments will imperil our nation's ability to regain the ground we have lost over the past two years.

Jain et al. (p. 24) describe a community-level seroprevalence survey conducted in Maricopa County, Arizona, by the county's department of public health in collaboration with Arizona State University. The authors' two-stage cluster sampling design yielded a COVID-19 seroprevalence rate that was 4.4 times higher than estimates derived from traditional public health reporting. The authors note that by using a door-to-door survey, they were able to reach out to vulnerable community members who were less likely to seek COVID-19 testing. This report beckons us to consider returning to the basics of shoe-leather epidemiology: going door to door in the community and obtaining data directly from community members is the type of task that can be carried out only by local health departments.

Also, Johnson et al. (p. 43) describe the San Francisco Department of Health's leveraging of novel chatbot technology to conduct contact tracing during COVID-19 surges as a means of offsetting workforce shortages. The chatbot was able to facilitate the collection and distribution of information in both English and Spanish, an important feature as Latinx individuals account for 40% of COVID-19 cases in San Francisco but only 15% of the population. Although information on contacts was collected more successfully via telephone interviews than via the chatbot, the latter technology was still able to provide information on ancillary services for individuals who had to self-isolate.

Finally, Porter et al. (p. 39) report on the development and deployment of health equity strike teams by the Arkansas Department of Health to address vaccine hesitancy and reduce disparities in COVID-19 vaccine uptake in the state. Media campaigns featuring trusted community leaders, educational campaigns to build community trust in the vaccines, and processes to simplify vaccine uptake were rolled out with the cooperation of several local community organizations. Together, these efforts resulted in significant increases in vaccination rates among adults 65 years or older and reduced vaccine disparities.

These articles highlight the creativity of local health departments in meeting the needs of their communities as well as the significant time, effort, and commitment to local partnerships that lead to these programs having a positive impact on the health of populations.

Despite these examples of successful public health department initiatives and many others—some described in previous issues of *AJPH*—trust in public health departments is in peril. Some people, instead of looking to their public health departments for information to prevent illness, scorn these institutions and their staff members. A recent study conducted by the Robert Wood Johnson Foundation showed that 71% of study participants favored increasing federal spending on public health activities and 72% supported the activities conducted by public health institutions as integral to the health of our population (https://rwjf.ws/3HPdAR9). However, the same study revealed substantially lower levels of trust in our nation's public health institutions. Specifically, 52% of respondents reported high levels of trust in the Centers for Disease Control and Prevention, 41% in state and local health departments, and 37% in the National Institutes of Health.

A report in the *New York Times* also details the multitude of ways in which the power of local health departments is being whittled away (https://nyti.ms/3cv99MU). Inconsistent funding, a lack of permanent employees, and high employee turnover will diminish the ability of local health departments—our frontline public health forces—not only to prevent future epidemics but to address the ongoing public health crises undermining our nation's health. Funding streams should not define what public health issues are of consequence in a given community. In fact, it is the other way around: local health departments must retain their authority to investigate and determine the health needs of their communities and make prevention and programmatic recommendations based on the local evidence.

As we begin to emerge from the COVID-19 pandemic, we must fully support all of the work in which health departments engage. This involves preparing for the next epidemic as well as returning to the prepandemic agenda: overdose prevention, childhood vaccinations, maternal and child health, oral health, mental health, and so forth. These are not and should not be controversial activities, and public health department employees must be able to carry out this work without fear of harm. This is public health of consequence, and this is what local and state health departments do. AJPH

CORRESPONDENCE

Correspondence should be sent to Farzana Kapadia, PhD, MPH, New York University, School of Global Public Health, 708 Broadway, Room 729, New York, NY 10003 (e-mail: farzana.kapadia@nyu.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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AJPH A PUBLICATION OF THE AMERICAN PUBLIC HEALTH ASSOCIATION **Call for Papers**

The First 1,000 Days

The ***American Journal of Public Health (AJPH),*** in collaboration with 1,000 Days, intends to publish a Supplement on "The First 1,000 Days: A Critical Window of Opportunity for Maternal and Child Nutrition and Health in the United States." This issue will highlight how policies, systems, and environments affect the nutrition of mothers and children during the first 1,000 days and summarize the state of the science and research needs related to maternal and child nutrition in the United States. Original research, systematic reviews, essays, and editorials are invited.

Topics of interest include, but are not limited to: maternal diet and nutrition during pregnancy and lactation; infant and young child feeding; community and workplace nutrition supports; and federal, state, local, and organizational policies and programs that support mothers and young children in the 1,000-day window. Papers should approach these topics through a public health lens; clinical or treatment studies are not of interest. Areas of special interest include: Equitable access to nutritious foods and optimal breastfeeding in the United States and related short- and long-term health outcomes, and proven policies and solutions to eliminate inequities and health disparities; gaps and successes in global maternal and child nutrition interventions in comparison to US approaches, and proven strategies to facilitate cross-learning and improvement; and gaps in knowledge and surveillance of maternal and child nutrition during the 1000-day window in the United States. **Read the full Call for Papers at: https://ajph.aphapublications.org/callforpapers.**

Potential authors should visit the *AJPH* website (https://www.ajph.org) to review the Instructions for Authors and specific guidelines for the various types of manuscripts. Importantly, submissions must include a cover letter formatted as requested in the Instructions for Authors. In all manuscripts, the number of words, references and tables/figures must correspond to a specific *AJPH* article format. All manuscripts will undergo standard peer review by the *AJPH* editors and peer referees as defined by *AJPH* policy. Manuscripts must be submitted to *AJPH* by **March 1, 2022,** and should be submitted at https://www.editorialmanager.com/ajph. For additional information about this supplement, contact: Guest Editor, Dr. Ruth Petersen (rpetersen@cdc.gov).

Guest Editors: Ruth Petersen, MD, MPH, Director, CDC's Division of Nutrition, Physical Activity, and Obesity
AJPH *Editor:* Stella M. Yu, ScD, MPH

Pregnant Behind Bars

Juana Hutchinson-Colas, MD, MBA, and Khadija AlShowaikh, MD

ABOUT THE AUTHORS

Juana Hutchinson-Colas and Khadija AlShowaikh are with the Women's Health Institute, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ.

The United States has witnessed a staggering 742% increase in the number of incarcerated women since 1980, primarily because of a complex phenomenon involving political, social, racial, and public health dimensions. Many incarcerated women are of childbearing age, are sexually active with men before incarceration, and do not use reliable contraception.[1] It is critical to identify and support pregnancy immediately upon entry to improve pregnancy outcomes.

In 2019, Sufrin et al. emphasized the importance of systematic reports on pregnancy data in prison. They published the first prospective study to collect data on pregnancy rates and outcomes in US prisons.[1] Their data, collected from 22 state prisons, showed that 4% of women were pregnant upon admission and that 0.3% became pregnant during incarceration pregnancies during a six-month follow-up period.[1] Unfortunately, a significant proportion of these incarcerated women experience unfavorable pregnancy outcomes, including miscarriages, preterm births, stillbirths, newborn deaths, and ectopic pregnancies.[1]

Pregnancy can be associated with many problems, from minor symptoms to life-threatening conditions. Incarceration jeopardizes maternal and fetal health, as pregnant incarcerated persons endure high levels of additional stressors and lower access to health care. Despite this, data on the pregnancies and their outcomes of women in prison remain underreported, resulting in health inequities and maternal health disparities. We highlight the current challenges for pregnant incarcerated persons and offer suggestions regarding humane practices and policies to optimize pregnancy outcomes.

HEALTHY PREGNANCY IN PRISON

Pregnant incarcerated persons are generally predisposed to poor pregnancy outcomes before imprisonment, often related to substance use, mental illness, chronic medical conditions, and lower socioeconomic status.[2] Only 38% of US jails perform pregnancy tests upon entry, delaying pregnancy diagnosis. The subsequent delays in access to early prenatal care and emergency services can have significant consequences for both the pregnant mother and her developing fetus.[2] Additionally, transportation challenges to health care facilities further delay antenatal counseling, testing, and routine visits.[2]

Although some pregnancy complications result from health and social issues that were in place before incarceration, the prison environment significantly affects pregnancy outcomes. Pregnant incarcerated persons are often shackled and separated from their newborns, negatively affecting pregnancy outcomes and mother–infant bonding.[2] Only 25% of US states provide mother–baby units (MBUs) in prison, and scant information is available on the services offered.[2] The inability to provide a supportive parenting environment leads to higher levels of mental health issues, behavioral problems, and risks of recidivism.[2] Existing MBUs currently allow children to coreside with their incarcerated mother until the child reaches age 12 or 18 months, regardless of the need for continued child support.[2] For most incarcerated mothers, the absence of MBUs leads to the immediate separation of mother and child and may result in the termination of parental rights.[2]

The continued lack of mandated implementation and regulation of health care standards in prison reflects a systematic failure in ensuring safe pregnancies with improved outcomes.[1,2] To appropriately address impediments to optimal pregnancy outcomes in prison, it is imperative to initiate systematic data collection. Although the Pregnant Women in Custody Act mentioned by Sufrin et al. is yet to be confirmed, the First Step Act was recently enacted, which prohibits shackling. The First Step Act provides some information on pregnancy outcomes in prison.[2] This is an encouraging step; however, the act is legally driven and applies only to federal facilities. Similarly, proposed guidelines and recommended minimal standards for the care of incarcerated pregnant women have not been uniformly implemented. An integrated approach to correctional health care between policymakers and health care professionals would be favorable for consistent documentation, reporting, and optimal outcomes.

DURING THE COVID-19 PANDEMIC

The unprecedented COVID-19 pandemic has complicated the consequences for pregnant incarcerated persons. The facts that prisoners have a high prevalence of chronic disease and that the correctional environment is a congregated setting are factors that lead to correctional facilities harboring highly infectious diseases.[3] Accurately describing the current COVID-19 mitigation practices, including vaccine availability for pregnant incarcerated persons, is challenging because of the wide variability in testing practices and data reporting across the United States. However, the confinement of incarcerated persons in poorly ventilated and overcrowded closed quarters coupled with limited and strictly controlled testing apparatuses, protective equipment, sanitary supplies, and precautionary guidance counteract the recommended preventive measures and increase the rate of contracting COVID-19.[3] As COVID-19 has evolved, protective supplies have been scarce, and knowledge has been unavailable, especially among the incarcerated population. Health literacy tends to generally be lower in the incarcerated population.[3] Hence tight control of information in prison may lead to higher rates of misinformation.[3]

Although the full ramifications of COVID-19 have not been not effectively studied in the incarcerated pregnant population, the physiological changes of pregnancy place pregnant incarcerated persons at higher risks for severe outcomes.[4] Symptomatic disease in pregnancy increases the need for invasive mechanical ventilation and carries higher mortality rates.[4] Severe disease is disproportionately greater for women of color, who constitute most of the incarcerated women population.[4]

Chmielewska et al. noted significant disparities in pregnancy outcomes between high-resource and low-resource settings during the COVID-19 pandemic.[5] The authors described higher maternal deaths, stillbirths, and ruptured ectopic pregnancies for women in low-resource settings in the general population; however, women in prison may have similar pregnancy outcomes.[5]

The effects of high incarcerated person turnover—as they are admitted, released, transferred to facilities, or transported to court dates and medical visits—and the interaction of correctional staff with external contacts further stress the correctional system because of the associated increased risk of infection.[3] Additionally, higher rates of mental health issues have been noted in the incarcerated population during the pandemic.[3]

MOVING FORWARD

Having established the current challenges that incarcerated pregnant women face, it is imperative to conduct national research, systematically collect pregnancy data in prison, and revise policies to ensure the safety of pregnant incarcerated persons and their babies.

Early access to antenatal care can be achieved by nationally standardizing pregnancy tests to women of childbearing age upon entry and 2 weeks after admission to prison. Pregnancy tests should also be readily available for incarcerated women beyond the admission period. Early pregnancy diagnosis allows effective pregnancy care and counseling, including termination and adoption.[2] This enables incarcerated women to have freedom of choice and control over their pregnancy and its outcome. Once pregnancy and its desirability are established, pregnant incarcerated persons must have access to routine care and educational resources equivalent to those of their nonincarcerated counterparts. Provision of transportation to attend prenatal appointments and telemedicine are essential to protecting incarcerated persons' rights to health care.[2,6]

Moreover, it is necessary to modify carceral settings to prevent easy transmission of infectious diseases. Social distancing, proper ventilation, and improved sanitation (including supplying soap, tissue, personal protective equipment, and laundry services) are vital in combating infectious diseases and alleviating the associated poor outcomes.[4,6] Offering incarcerated persons COVID-19 testing and vaccinations also reduces the disease burden in prison.[4,6]

Legislating pregnancy-specific programs, including MBUs and doula programs, has shown beneficiary outcomes for pregnancy in prison.[2] These programs aim to improve mother–infant bonding by creating an informative, supportive, and child-friendly environment. They allow incarcerated women to receive parental training, including breastfeeding education, maintain their parental rights, and promote healthy child development.[2] The close follow-up of pregnant incarcerated persons by doulas or at MBUs may have a significant role in data collection and the evaluation of pregnancy outcomes.

Applying reforms secures the safety of a predominantly marginalized population and, subsequently, protects community health. Therefore, a collaboration between health care providers, correctional facilities, and policymakers is vital to ensure equal health care for all. AJPH

CORRESPONDENCE

Correspondence should be sent to Juana Hutchinson-Colas, MD, MBA, Associate Professor, Women's Health Institute, Rutgers Robert Wood Johnson Medical School, 125 Paterson St, CAB 2155, New Brunswick, NJ 08901 (e-mail: hutchij2@rwjms.rutgers.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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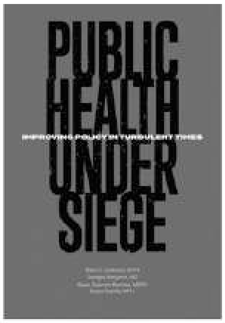

Ballroom Icons and the Power to Promote COVID-19 Vaccination Among Black and Brown LGBTQ+ Individuals

Randi Beth Singer, PhD, Natasha Crooks, PhD, Rebecca Singer, PhD,
Noel Green, BS, Jahari Stamps, Crystal Patil, PhD, and Alicia Matthews, PhD

ABOUT THE AUTHORS

Randi Beth Singer, Natasha Crooks, Rebecca Singer, Crystal Patil, and Alicia Matthews are with the College of Nursing, University of Illinois Chicago. Noel Green is with the Chicago Center for HIV Elimination, University of Chicago. Jahari Stamps is with the House of Ferre, Chicago.

COVID-19 mortality is inequitably affecting communities of color in the United States. The rate of COVID-19 among Black and Latinx Americans is more than double that among Whites.[1–4] Black individuals account for 13.4% of the US population, yet they constitute 24% of COVID-19 deaths.[5(p19)] Disproportionately represented as essential workers, Latinx individuals are 1.9 times more likely than Whites to contract COVID-19, 2.8 times more likely to be hospitalized, and 2.3 times more likely to die from COVID-19.[1,4] Also, research has shown that in Chicago, Illinois, Black and brown individuals have died of COVID-19 at higher rates than others.[6,7]

Systemic racism has led to many individuals experiencing housing instability, job insecurity, and food deserts.[3,5,8,9] This systemic oppression increases the incidence of diabetes, hypertension, and other comorbidities, thereby worsening the impact of COVID-19.[5(p1),10] To support vaccination uptake among communities of color, we must address dissuasive barriers such as concerns about missing work to obtain the vaccine, inadequate information related to vaccine affordability, and historical mistrust of the health care system stemming from medical abuse of Black and brown bodies.[5,9,11]

Examples of abuse abound, including forced sterilization of Puerto Rican women, removal and storage of Henrietta Lacks's cervical cells, and the Tuskegee Syphilis Study.[10,12] More recently and relevant to COVID-19 vaccines, there have been lawsuits claiming that Johnson and Johnson did not properly disclose the link between its baby powder and ovarian cancer, instead continuing to market the product aggressively in Black and brown communities.[13] This history of abuse and oppressive research contributes to many feeling unsafe in following public health advice.

RACE, SEXUAL ORIENTATION, AND GENDER IDENTITY

The intersection of race, gender, and sexuality within Black and brown LGBTQ+ (lesbian, gay, bisexual, transgender, queer or questioning, and others) communities compounds stigma, oppression, and health disparities.[9,14] Although these communities continue to experience blame, shame, and stigma correlated with infectious diseases such as HIV/AIDS (and other sexually transmitted infections), historical myths and conspiracies about HIV/AIDS being a "white gay male disease"[15] have led to exclusion of Blacks from AIDS organizations, resources, and information. After decades of medical neglect and mistrust shaped by racism and homophobia, HIV/AIDS disparities persist among Black gay men.[5,16] These lived experiences may contribute to COVID-19 vaccine hesitancy among the Black and brown LGBTQ+ community.

Communities of color, who make up 42% of the LGBTQ+ population, are less likely to receive a COVID-19 vaccine than their White, cisgender, and heterosexual counterparts.[17] In Chicago, vaccines are generally available, yet perceived lack of access and vaccine hesitancy have caused vaccination efforts to stall. Access is hindered by transportation challenges, limited clinic hours, lack of knowledge about where to access vaccines, and requirements for preregistration or appointments. Although access and hesitancy are distinct issues, initiatives addressing both are needed to increase vaccinations.[17]

In response to the needs of those with decreased access to vaccinations, the University of Illinois Chicago and the City of Chicago Department of Public Health have collaborated to increase vaccination rates. The COVID Rapid Response Team (CRRT), a collaboration between the University of Illinois Chicago's Colleges of Nursing, Pharmacy, and Medicine and the department of public health, has been working since the

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earliest days of the pandemic to reach vulnerable individuals living and working in congregate settings (shelters for those experiencing homelessness, residential treatment centers, correctional institutions, and long-term care facilities).[18,19] Since March 2021, the team has engaged in vaccination efforts in these settings as well as in subsidized housing and social service agencies.

Using trauma-informed approaches,[20,21] CRRT has delivered the vaccine to more than 1500 people. Relying on approaches such as motivational interviewing,[22–24] CRRT aims to honor people's experiences through trauma-informed care while providing vaccine education. In keeping with the mission of CRRT, the Black LGBTQ+ House Ball Community and CRRT are partnering to increase uptake of the COVID-19 vaccine.

VACCINATION IN CELEBRATION OF HOUSE BALL COMMUNITY

With COVID-19 restrictions lifting, the House Ball Community is resurfacing. House Balls celebrate Black LGBTQ+ culture and highlight the charisma, uniqueness, nerve, and talent of this community.[25] In addition, House Balls and shows such as *Pose* have shed light on the history of HIV/AIDS in the community.[26] Recently, Billy Porter (an Emmy Award winner for his work on *Pose*) has broken his silence about being HIV positive,[27] representing how one can successfully live with HIV. House Balls in Chicago draw more than 350 people who compete in 25 categories such as voguing, drag realness, and realness with a twist.

Participants are typically affiliated with houses, which are families of choice (rather than physical structures). All houses have names (e.g., House of Verocity, House of Gucci) and parents (e.g., Father Jahari Stamps). House parents provide a structure of support for Black and brown individuals who identify as LGBTQ+. As trusted mentors, they have historically protected their children by providing a safe haven, teaching survival techniques, and fostering creative expression. House parents have the power to lead by example and support healthful innovation. Many houses rely on community-based organizations such as CRRT to support House Balls as venues at which individuals can socialize while accessing health-related resources.[28]

Chicago House Balls are usually held on the city's south side, an area regularly served by CRRT. In celebration of creativity and in response to the needs of the Black and brown LGBTQ+ communities, CRRT connected with the city of Chicago and House Ball organizers to offer COVID-19 vaccines at a ball on May 16, 2021. Responses were mixed. CRRT vaccinated 13 individuals on the sidewalk outside of the venue and spoke to hundreds in line for the ball. Some were already vaccinated, but others shared their reasons for holding off, including seeing TikToks or online viral videos discouraging vaccination. Several believed that their COVID-19 experience was out of their hands. One person mentioned that "God has a plan," and another stated that "I haven't been social distancing this whole time and I've been fine."

Misinformation about the role of boosters came up when someone said "Why would I get vaccinated now if I have to get revaccinated in six months anyway?" Another statement reflected a lack of understanding about the role of the vaccine in reducing severity: "I can still contract COVID-19 if I am vaccinated!" Trust also came up. One person was concerned about a lack of cultural concordance, stating that "I am going to trust someone that looks like me who says don't do it before I trust you [saying that I should be vaccinated]." Others did not want the vaccine offered; for example, according to one individual, "I don't trust Johnson and Johnson. Their powder sucks so I can't even imagine what they would do to a vaccine." Finally, the practicality of the approach was questioned when someone prioritized the opportunity to enter the ball over the vaccine by saying "I don't want to lose my place in line to get vaccinated." Two individuals who were excited to get vaccinated at the ball changed their minds after peers questioned the safety and legitimacy of vaccination.

Given the importance of houses and families, there is an opportunity to engage with House Ball Community leaders to overcome some of these barriers. After having been hesitant, House Ball legend (and coauthor of this article) Jahari Stamps chose to get vaccinated at the ball in May. His rationale was

> to set an example for my sons and daughters and the community I call family. . . . I have to be the message that I bring to other people and my message is that this is bigger than our personal hang-ups. If we want to return to a level of normalcy, we need to get vaccinated not only to protect ourselves but also to protect the community I love. (Verbal Communication, May 31, 2021)

A CALL TO ACTION

Similar to successful outreach efforts related to HIV prevention, this anecdote suggests that a potentially effective approach is to engage house parents who are community leaders and legends. Diffusion of innovation theory has been used to promote behavioral change, and interventions that lean on this theory are effective because they consider early-, middle-, and late-stage adopters of change.[29] In keeping with this theory, House Ball icons such as Mario Balenciaga and other well-known house parents must be the face of safety to encourage others to follow suit. These community leaders are the individuals who can make the case for vaccination, and House Balls are the perfect venue for "one-and-done" vaccine delivery.

The lessons learned at the May 16 ball led to a change in strategy for a subsequent ball. Strategies implemented at the Paragon Ball on July 3, 2021, were in alignment with CRRT's foundation of trauma-informed care and included a request for community leaders to be present and available for support during recruitment and vaccination. Respected leaders approached individuals entering the venue and encouraged them to get vaccinated. They offered to accompany individuals as they filled out the paperwork and received the vaccine. Vaccination took place in the lobby as people entered the ball, and thus they did not lose their place in line. Furthermore, a screen was erected to provide a semblance of privacy.[29] Palm cards stating the advantages of vaccination were distributed to ball attendees by community leaders and house parents. One side of the card had pictures of vaccinated icons, and the other side included a direct quotation acknowledging why the icon chose to become vaccinated.

A team of House Ball legends, house parents, public health nurses, and psychologists came up with ways to integrate vaccination into the ball experience.[19] Although many individuals reported being vaccinated, approximately 5.5% of Paragon House Ball attendees were vaccinated at the ball, indicating that such outreach strategies may be an effective way to reach this population. An anecdotal indicator of success is that the MC of the ball took a break to get vaccinated after having been dissuaded by friends at the May event.

Although 5.5% might not seem like a large percentage, CRRT holds the philosophy, propounded by the Chicago Department of Public Health, that each person vaccinated is a life saved. In addition, each person vaccinated has the potential to persuade reluctant friends and family members, the late majority and laggards, to get vaccinated. Working with the Chicago Center for HIV Elimination, we will integrate these methods again at the Back to Basics Ball in October, where we plan to reach those who have yet to be vaccinated and hope to provide booster shots for those who qualify.[30]

There are complex social and structural factors involved in COVID-19 vaccination (similar to HIV), including the intersection of race, sexual orientation, and gender identity, that keep in place historical barriers to accessing health promotion services; therefore, we can draw on the impact demonstrated by innovative HIV programs to better support the House Ball Community.[31] To connect with underserved and difficult-to-reach populations, there is a clear need for innovative approaches. This is a first step. AJPH

CORRESPONDENCE

Correspondence should be sent to Randi Beth Singer, PhD, University of Illinois Chicago, College of Nursing, Department of Human Development Nursing Science, 845 South Damen Ave, Chicago, IL 60612-7350 (e-mail: rbsinger@uic.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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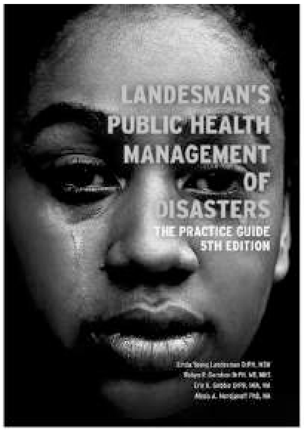

American Single Father Homes: A Growing Public Health Priority

Stacey L. Shipe, PhD, MSc, MSW, Lynsay Ayer, PhD, and Kate Guastaferro, PhD, MPH

ABOUT THE AUTHORS

Stacey L. Shipe and Kate Guastaferro are with the Child Maltreatment Solutions Network, College of Health and Human Development, Pennsylvania State University, University Park. Stacey L. Shipe is also with the Department of Social Work, State University of New York, Binghamton. Lynsay Ayer is with the RAND Corporation, Arlington, VA.

Children and families in the United States have suffered greatly throughout the COVID-19 pandemic. School shutdowns, unprecedented job loss, and the grief and loss related to COVID-19 deaths have highlighted the mental health and financial needs of parents—particularly single parents. Yet, when the struggle of pandemic parenting is discussed, it is often focused on the needs of mothers. It is important, however, to not overlook the needs of single fathers—one of the fastest-growing populations in the country; the number of single fathers in the United States grew from approximately 1.7 million in 1990 to 3.3 million in 2020.[1] Research indicates that single fathers suffer from similar barriers as single mothers, but institutional stereotypes about fathers (e.g., a perceived lack of interest in child-rearing) make some barriers more gender specific.[2] The struggles of single fatherhood, coupled with the prolonged COVID-19 pandemic, highlight that supporting this hidden but sizable population of caregivers is a public health priority. We review some of the current evidence on the characteristics and needs of single fathers and outline recommendations for research, practice, and policy.

UNIQUE CHARACTERISTICS AND CHALLENGES

Single fathers are demographically distinct from married fathers. Single fathers are less educated, considerably younger (18% are younger than 30 years compared with 8% of married fathers), and 24% live at or below the poverty line (compared with 8% of married fathers).[3] Single fathers are more likely to identify as Latino (24% vs 17% of married fathers) or African American (15% vs 7% of married fathers).[3] Importantly, Latino and African American fathers do not fare as well economically. Because of structural racism, they are more likely to experience incarceration, unemployment, poor health, and homelessness than are their White counterparts.[4,5] This ultimately affects how single fathers access and receive needed services and supports.

The social assumptions related to single fathers' ability to nurture and financially provide for their children create unique challenges. Single fathers report that this dual role causes them a great deal of stress, which is exacerbated when interacting with social service caseworkers and health care providers, who often question their discipline approaches and dedication to their children.[2,4,6] Specifically, single fathers applying for social services reported that they felt they received substandard customer service and that they were forced to manage more bureaucratic hurdles compared with their female counterparts.[2,4] The fathers attributed these negative experiences to societal assumptions about who should be the primary caregiver or not believing the father when he states that the mother is not involved with the children.[4] The gendered role of being the sole provider coupled with pride leads many single fathers to rely on informal social networks (e.g., extended family or male-oriented support groups) over governmental systems for help with financial needs, educational understanding, medical advice, and general parenting concerns.[2,4,6]

Compared with other family heads (e.g., single mothers, married couples, or cohabiting caregivers), single fathers tend to utilize health and behavioral health services for their children at lower rates. Children of single fathers have the lowest percentage (59%) of annual well-child visits to a consistent pediatrician compared with children of other family heads (e.g., 72% for married couples, 71% for single mothers, and 69% for cohabitating families) and are less likely to adhere to medical advice.[7] Specific to behavioral health concerns, children of single fathers have higher rates of externalizing behaviors (i.e., delinquency, antisocial behavior) and substance use relative to children living in other family structures.[4,7]

SINGLE FATHERS IN THE COVID-19 CONTEXT

Overall, health care utilization decreased during the COVID-19 pandemic for children and adults.[8] Yet, in the event someone in the single father home becomes ill, the challenges of health care access and limited childcare options are compounded.[6] When race and ethnicity are factored into the health outcomes of COVID-19, there are distinct differences between White individuals and people of color.[9,10] African Americans, Asian Americans, Latinos, Pacific Islanders, and Indigenous communities have disproportionately suffered as a result of the pandemic (e.g., having less access to quality health care, working as frontline responders). It is likely that single fathers and their children, who are more likely to be people of color, are especially susceptible to the negative and long-lasting impacts of the COVID-19 pandemic.

A CALL TO ACTION

Akin to research trends, prevailing public health messaging and programming designed to support parents should engage all family structures. We provide suggestions to ensure that single fathers are seen as a public health priority by targeting four main areas: health care bias, engagement strategies, research priorities, and policy changes.

Improve Awareness of Health Care Biases

Single fathers are not exempt from the long history of biases in health care. Indeed, some single fathers have reported being overlooked and untrusted when obtaining services.[2,4,6] One step in preventing this is to increase providers' awareness that these biases are common and encourage them to more actively engage single fathers in their health care as well as their children's.

Enhance Engagement of Single Fathers

Practitioners in social service agencies, pediatric offices, and school buildings must be cautious in the language they use and not assume the primary parent is a mother or female. Practitioners can also help by communicating directly with fathers rather than through the child or other caregivers. Because many single fathers rely on employment that is traditionally labor intensive (e.g., construction), their hours may not follow traditional business hours, and taking time off could equate to lost wages.[9] Practitioners (health and behavioral health) and service agencies should offer virtual options for connecting with caregivers and visiting times during nonbusiness hours (e.g., after 5:00 PM or weekends). Among child-serving agencies (e.g., social services, schools, daycares), practitioners would benefit from training in strategies that improve father engagement. In general, we recommend that public health messaging be inclusive and gender neutral.

Prioritize Fathers in Research

Studies conducted before the COVID-19 pandemic suggest that single fathers have high rates of stress, anxiety, and depression but are less likely to seek out mental health treatment.[4,6] Given the ongoing COVID-19 pandemic, we recommend further examination of the impact of COVID-19 on these key health dimensions as well as on single fathers' children's health and behavioral health, service utilization, academic achievement, and intra- and interpersonal relationships, as there are no known studies on these subjects. To date, only one study focused on this parent group during the pandemic. The author concluded that fathers struggled with social isolation and fear of contracting the disease coupled with fears about keeping their children safe.[6] In the year since this study concluded, the pandemic has worsened in most communities, leaving many unanswered questions about its long-lasting impact on single fathers and their children. We suggest that there needs to be an emphasis and available funding for researchers to focus on single fathers' health and social service utilization and well-being, including health and behavioral health, employment, housing, parenting stress, and social support.

Create Equitable Policies

All parents would benefit from policies geared toward raising children, such as childcare subsidies and protected time off to deal with unexpected issues like illness. The United States has few protections related to childcare, and the few that do exist are often unpaid time off, which is often unfeasible for single parents. When raising children alone, especially in a gendered society, both male and female parents feel pulled between being the sole breadwinner and taking care of their children.[4,6] Although many single fathers make more in wages than single mothers, at least one third are at or below the federal poverty line.[3,4] State welfare, and ideally federal policies, need to be augmented to include fathers as a known population of service receipt. Abandoning gendered language in such policies, for example, can go a long way toward supporting all families, including those with single fathers.

We have argued that single fathers head a minority family structure with different needs because of gendered stereotypes about family and parenting. These unique concerns may result in adverse outcomes, such as unstable housing and inadequate childcare. This in turn affects the children of single fathers so that they are at higher risk for mental health problems, substance use, school problems, and limited access to needed medical and mental health services.[4,7] Gender stereotypes also harm women by perpetuating the assumption that their principal function is to be the primary caregiver, often at the expense of their well-being. These concerns are amplified in the current pandemic, as all parents have struggled with the stress to stay employed, educate their children, and maintain their homes. Better supporting single fathers could help to reduce the pressure on all parents to choose between professional and caregiver identities, with benefits for the entire family's health and well-being. Although the population of single fathers may be relatively small, it continues to steadily grow.[3] From a public health perspective, social policies, norms, and services must respond to and adapt accordingly. AJPH

CORRESPONDENCE

Correspondence should be sent to Stacey Shipe, Child Maltreatment Solutions Network, College of Health and Human Development, Pennsylvania State University, 201B Henderson Building, University Park, PA 16802 (e-mail: sks6864@psu.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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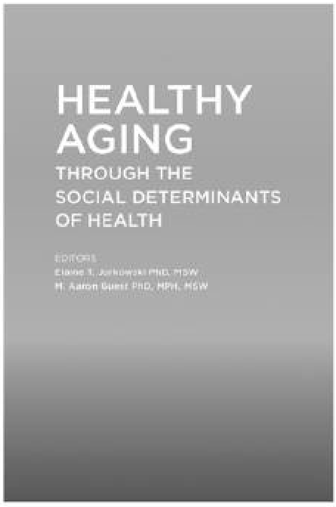

All Infrastructure Is Health Infrastructure

Bhav Jain, Simar S. Bajaj, and Fatima Cody Stanford, MD, MPH, MPA, MBA

ABOUT THE AUTHORS

Bhav Jain is with the Massachusetts Institute of Technology, Cambridge, MA. Simar S. Bajaj is with Harvard University, Cambridge, MA. Fatima Cody Stanford is with the Massachusetts General Hospital (MGH), MGH Weight Center, Departments of Medicine (Division of Endocrinology-Neuroendocrine) and Pediatrics (Division of Endocrinology), and the Nutrition Obesity Research Center at Harvard (NORCH), Boston, MA.

Flint's water crisis. Texas' power grid failure. Miami's Surfside tower collapse.

The nation's crumbling infrastructure has brought rare bipartisan consensus for legislation to modernize America. In late March, President Biden presented the comprehensive American Jobs Plan that would invest $2.7 trillion into such infrastructure, but a more curtailed bipartisan framework, the Infrastructure Investment and Jobs Act, has since passed Congress and been signed into law. Much of the debate surrounding these bills centered on the inclusion of human infrastructure within what is traditionally defined as infrastructure, and the resulting acrimony underscored the precarious nature of any potential agreement in a narrowly divided Congress. Infrastructure has often been described in relation to energy, commerce, and transportation, yet these intersections underlie a larger conversation about social determinants of health and the intrinsic connections between infrastructure and human health. Although there has been a dichotomy between traditional infrastructure and human infrastructure, as health care professionals and patient advocates, we must recognize that all infrastructure is fundamentally health infrastructure.

The current administration carefully defined human infrastructure to encompass investments in child care, education, and home- and community-based services (HCBS). Although no previous national legislation considered these services part of American infrastructure, their inclusion in the American Jobs Plan is a reminder of the intrinsic connections between health and infrastructure rather than partisan spending. Indeed, investments to upgrade and build new child care facilities are critical not only because the industry has been decimated by the pandemic but also because access to care and high-quality learning environments are critical to stimulate development and promote health.[1] The current paucity of child care—enough to serve only 23% of infants and toddlers—leads many mothers to leave the workforce and experience economic instability, a well-known social determinant of health.[2] The American Jobs Plan, moreover, prioritizes educational investments toward improving kitchens to prepare more nutritious meals and enhancing air quality and ventilation systems to protect against environmental health hazards. Given that a majority of American public schools are over 50 years old, asbestos and mold exposure, as well as the 72 million metric tons of carbon dioxide emitted each year, are significant challenges to child health and education as a foundation for individuation, underscoring the import of modernizing schools.[3,4] The final component of the American Jobs Plan as it relates to human infrastructure lies in "care infrastructure" and specifically bolstering HCBS. The majority of older adults and persons with disabilities wish to age and live independently, but HCBS are optional services under Medicaid, resulting in poor local care delivery and subsequent barriers of access. Eight hundred thousand people are on state waiting lists, thousands of whom die each year without receiving services.[5] As such, addressing America's crumbling care infrastructure may require expansion of access to HCBS and greater support for the direct care workforce, given labor shortages and the need for one million care workers by the end of the decade. These investments will better allow older adults to receive long-term and end-of-life care within their homes and communities rather than institutional settings, which are associated with higher hospital readmissions, increased complications, and unnecessary costs.[6] Investments into human infrastructure represent an investment into American health.

Importantly, however, the relationships between infrastructure and health extend well beyond what has been labeled human infrastructure; there is a false dichotomy when we separate human infrastructure and physical infrastructure because all infrastructure has concrete consequences for human health and well-being. For instance, modernizing water infrastructure would eliminate lead pipes and protect against a crisis like that in Flint, Michigan, by targeting the 10 million homes that are at risk for lead exposure.[7] Investments into roads, bridges, transit, and electric vehicle chargers offer a similar opportunity to invest—or, conversely, regress—in our nation's environmental health. There are opportunities to reshape the American landscape away from its automobile-centric design and reimagine a more accessible, human-friendly future where walking, biking, and public transport are the norm, not the exception. Simultaneously, there are opportunities to preserve the status quo in which single-occupant mobility predominates and contributes to significant air pollution, poor road safety, and limited physical activity. Infrastructure's health implications, either constructive or destructive, are unequivocal. Even investments into broadband access, which have received bipartisan support given that they address rural–urban disparities, are intrinsically tied to human health. Beyond being fundamental to accessing online health resources and connecting with medical personnel via telehealth, broadband is known as a "super determinant" of health because it intersects with everything from employment and educational opportunities to the social context, serving as a platform to engage with the world.[8] Road, water, and broadband infrastructure is indeed critical infrastructure, in no small part because of its contributions to human health.

The $1.2 trillion bipartisan infrastructure bill makes vital investments into physical infrastructure while largely leaving out human infrastructure. This separation reinforces an artificial divide between physical and human infrastructure and ignores the inextricable connections of both types of infrastructure to the fabric of American society. A framing that brings together physical and human infrastructure under the banner of health infrastructure would offer an opportunity to robustly address various social determinants of health and extend unifying focus to this historic investment. When policymakers debate and consider infrastructure, they must do so in a framework that considers the short- and long-term consequences on patient health, as well as how the project can maximize community benefit (Box 1).

Such a framework can be considered a continuance of the "Health in All Policies" (HiAP) approach, which endorsed intersectoral collaborations to address health disparities.[9] HiAP projects have seen great success internationally. For instance, Finland's North Karelia Project reduced the nation's coronary heart disease burden by engaging community organizations, dairy and meat producers, and schools. Similarly, Thailand mandated Health Impact Assessments at every level of government to combat emerging health challenges caused by air pollution, pesticide contamination, coal-fired power plants, and other environmental hazards. In the United States, California's Health in All Policies Task Force spearheaded the first efforts to integrate transportation, housing, affordable healthy food, safe neighborhoods, green space, and policies' health consequences into state programs. However, HiAP implementation has been more fragmented across the United States as a whole. A national HiAP approach to traditional and human infrastructure would not only better reframe the debate and deconstruct this false dichotomy but also provide a template

BOX 1— Key Actions for Developing Infrastructure Legislation

Action	Example
Delineate the communities affected, the existing health challenges they face, and how the infrastructure will immediately ameliorate or exacerbate these health challenges.	With proposals to build new freeways and housing developments, the first questions on the table should be, "Which neighborhoods will be displaced in the process? Who lives in these neighborhoods? Who will be the beneficiaries of the new housing developments? Will these infrastructural changes make it easier or more difficult for current residents to access employment opportunities and health care facilities?"
Consider long-term health consequences associated with infrastructural investments.	Although freeways may serve as connections to jobs and produce economic growth in distressed communities, the resultant pollution from largely external traffic and deleterious health consequences may outweigh any short-term benefits.
Engineer infrastructure projects to simultaneously provide communities multiple benefits.	With new freeway construction comes opportunities to reroute underground pipes to provide communities with cleaner drinking water, among other projects. Additionally, after the freeway has been constructed, can local community members be hired to regularly maintain the pavement, thereby minimizing greenhouse gas emissions from vehicles?
Scale successful infrastructure initiatives from the local and state levels based on evidence of tangible and quantifiable health benefits.	In the late 1990s, the New Communities Program in Chicago, Illinois was implemented,[10] which focused on engaging residents in the preparation of a community quality-of-life plan, as well as early childhood development and youth programs across 5 programmatic domains: housing and real estate, connection to regional economies, family income and wealth generation, education, and public health and safety. This model is now operating in almost 100 neighborhoods in 24 other metropolitan areas.

for greater intersectoral collaborations that could advance public health in the United States.

With infrastructure ubiquitously occupying news cycles and Washington alike, medical professionals have a responsibility to frame infrastructure as a medical concern and guide future discussions toward health considerations. Infrastructure can be a vehicle to make historic investments into American health, but doing so will require that legislators actively make these connections and strengthen all future infrastructure bills to that end. AJPH

CORRESPONDENCE

Correspondence should be sent to Fatima Cody Stanford, MD, MPH, MPA, MBA, 4th Fl, Weight Center, 50 Staniford St, Boston, MA 02114 (e-mail: fstanford@mgh.harvard.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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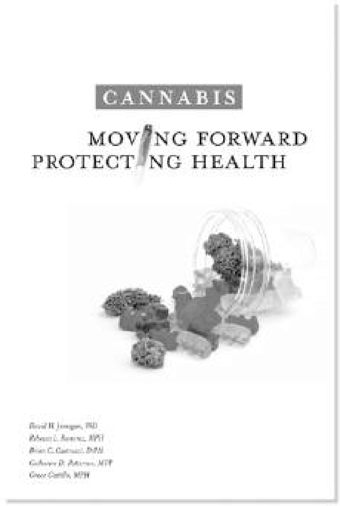

Global Sharing of Public Health Information: From *MMWR* to *China CDC Weekly*

Peter Hao, MS, George F. Gao, DPhil, and Feng Tan, MS, MBA

ABOUT THE AUTHORS

The authors are with the Chinese Center for Disease Control and Prevention, Beijing Municipality, China.

China CDC Weekly's inaugural issue was published less than 2 months before the first reports of COVID-19 emerged in China. Since then, the *Weekly* has continued to evolve alongside the needs of the global health community to access and to share updated data and novel findings. The COVID-19 pandemic has tested the ability of public health agencies to respond and protect their people while pharmaceutical solutions can be developed, and the open sharing of comprehensive, up-to-date data and state-of-the-art technologies has been the cornerstone of formulating and refining local, regional, and national responses in an increasingly connected and interdependent global system.

National public health bulletins are key to maintaining channels to promptly disseminate research and public health practice data and findings. The US Centers for Disease Control and Prevention's (CDC's) *Morbidity and Mortality Weekly Report* (*MMWR*), a defining example of the importance of a national public health bulletin, has closely tracked the evolution of the outbreaks and epidemics of AIDS,[1] H1N1 swine influenza A (later renamed 2009 pandemic influenza A H1N1),[2] Ebola virus,[3] and others. And, beyond infectious disease outbreaks and public health emergencies, many data on public health and disease control issues were disseminated and shared both nationally and internationally in an academic way; thereafter, the novel strategy and technologies were put into practice. By examining the *MMWR*'s publication history, we can see how these public health crises evolved from initial reports of localized incidents to global sharing of research data.

The rapid development of China's public health infrastructure, socioeconomic conditions, and ability to participate in global affairs has necessitated an *MMWR*-equivalent public health bulletin, which was ultimately achieved with the *China CDC Weekly*. Increased communication and cooperation in global health depends on providing trusted resources for building more comprehensive understanding of existing circumstances and refining action plans based on the experiences of other researchers and experts. The *Weekly* aims to join the *MMWR*, *Eurosurveillance*, and the *Journal of Public Health in Africa* in providing another cache of high-quality research to be utilized and referenced.

In the year since its inaugural issue, the *Weekly* has published more than 160 novel research studies and reports, has had readers from every country and territory, and has accumulated millions of page views. The *Weekly* has also encouraged global experts to share their perspectives on important public health challenges and has published insights by former US CDC Director Tom Frieden[4] and European Centre for Disease Prevention and Control Director Andrea Ammon,[5] among others. Throughout the COVID-19 pandemic especially, the *Weekly* has prioritized sharing breakthrough findings and data, such as the genomic sequencing results of the viruses from the first cases in Wuhan, China;[6] the first large-scale epidemiological analysis of more than 70 000 cases in China;[7] and the recent confirmation of material-to-human mode of transmission of the virus. In addition, the *Weekly* maintains a monthly update of the National Notifiable Disease Reporting System that provides the updated number of cases and deaths attributable to more than 40 infectious diseases.

Looking forward, the *Weekly* aims to take on additional responsibility by promoting mutual information exchanges and, similarly to the *MMWR*, publishing more global health data that are broader in scope. This goal is meant to foster bilateral and multilateral cooperative relationships that improve data sharing to the global community—partnerships like the cooperative effort between China's public health experts and the Africa Centres for Disease Control and Prevention. China's public health community has closely followed the circumstances and development of Africa's public health, and we at the

Weekly hope to maintain and develop communications with the *Journal of Public Health in Africa* and other regional scientific journals. In this manner, the *Weekly* hopes to continue promoting the development of public health communication and data sharing and to provide new tools to the global community to achieve progress toward the United Nations' 17 Sustainable Development Goals. AJPH

CORRESPONDENCE

Correspondence should be sent to Peter Hao, MS, Chinese Center for Disease Control and Prevention, No.155 Changbai Road, Changping District, Beijing 102206, China (e-mail: phao@umich.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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Deployment of Health Equity Strike Teams to Address COVID-19 Vaccine Disparities in Arkansas, 2021

Austin Porter, DrPH, MPH, Samantha Wells, MPH, CPH, Chimfumnanya Smith, DrPH, MPH, CHES, Namvar Zohoori, MD, MPH, PhD, George Pro, PhD, MPH, and Michelle R. Smith, PhD, MPH

See also Kapadia, p. 12.

Minority populations have been disproportionately affected by the COVID-19 pandemic, and disparities have been noted in vaccine uptake. In the state of Arkansas, health equity strike teams (HESTs) were deployed to address vaccine disparities. A total of 13 470 vaccinations were administered by HESTs to 10 047 eligible people at 45 events. Among these individuals, 5645 (56.2%) were African American, 2547 (25.3%) were White, and 1068 (10.6%) were Hispanic. Vaccination efforts must specifically target populations that have been disproportionately affected by the pandemic. (*Am J Public Health*. 2022; 112(1):29–33. https://doi.org/10.2105/AJPH.2021.306564)

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The ongoing COVID-19 pandemic has resulted in significant loss of life, with more than 3 million deaths worldwide and more than 645 000 deaths occurring in the United States as of September 1, 2021.[1] Although the pandemic has touched nearly every community in the United States, African Americans, Hispanics, and other minority groups have been disproportionately affected.[2] Similar to the disparities seen in COVID-19 infections and mortality, disparities are being observed in vaccination rates. For example, African Americans represent 12.4% of the US population but only 9.3% of those fully immunized.[3] Hispanics are underrepresented as well, accounting for 17.2% of the population as compared with 16.1% of those fully immunized.[3]

The vaccine disparities seen at the national level also exist in Arkansas, a southern state with relatively large rural, poor, and racial/ethnic minority populations.

INTERVENTION

To address the disparities just described, the Arkansas Department of Health's Office of Health Equity established health equity strike teams (HESTs) to target minority communities throughout the state. HESTs comprise nurses, health educators, public information specialists, and lay community members with skills to foster community relationships and encourage vaccination uptake. HESTs use volunteer groups to staff community vaccination events and assist local pharmacists with data entry into WebIZ, the state's immunization registry. The overarching goal of HESTs is to increase vaccination rates in communities disproportionately affected by the pandemic by rapidly disseminating health information and supporting new and ongoing vaccination clinics in trusted locations.

Data from WebIZ were used to present HESTs with weekly county-level reports highlighting proportions of eligible vaccinated populations by race and ethnicity along with the racial and ethnic compositions of each county in the state. Population estimation data from the US Census Bureau were used to calculate the racial and ethnic distributions for each county and the state. These reports focused on individuals 65 years or older because this population was eligible to receive the vaccine during the evaluation period. The reports allowed HESTs to compare the proportion of eligible residents who have been vaccinated with the proportions of eligible residents at the county and state levels. Disparity calculations were conducted by subtracting the proportion of the minority population receiving the vaccine from the proportion of the minority population at the county and state levels; a negative vaccine disparity indicated that the racial/ethnic group in question was underrepresented among those vaccinated.

The reports also helped HESTs identify counties with the largest vaccination disparities and plan community outreach and vaccination events. These events were planned to accommodate the two-dose regimen for the Pfizer and Moderna vaccines, with HESTs conducting follow-up events for the second dose.

To address vaccine hesitancy among minority communities, the Office of Health Equity worked with community partners to develop an education campaign to build public trust, simplify the vaccination process, and disseminate prevention materials. Messages from trusted leaders sharing their intent to take the vaccine when it was their turn were used to tailor the campaign to the needs of diverse populations within the state; these messages were posted on YouTube and Facebook and included in radio advertisements. Videos made in English, Spanish, and Marshallese featured these leaders getting vaccinated and documenting their experience. In addition, pamphlets about monoclonal antibody treatment and the Centers for Disease Control and Prevention's V-Safe program were distributed at vaccination events.

PLACE AND TIME

HESTs were dispatched throughout Arkansas starting in January 2021, and efforts are ongoing.

PERSON

The HEST vaccination efforts were available to anyone eligible. However, the target population was eligible people in minority communities, particularly those 65 years or older.

PURPOSE

HESTs were deployed to assist state efforts related to ensuring that minority communities and difficult-to-reach populations had equal access to the vaccine. The purpose of our evaluation was to describe the impact of HESTs in reducing vaccination disparities in Arkansas.

IMPLEMENTATION

HESTs rely on partnerships with the Arkansas Pharmacy Association, the Black Mayors Association, the Legislative Black Caucus, historically Black fraternities and sororities, Arkansas Blue Cross/Blue Shield, Wal-Mart, and Walgreens. Only clinical HEST members administer the COVID-19 vaccine. Health educators provide education and create videos to address vaccine hesitancy.

EVALUATION

HESTs held 45 targeted community vaccination events in nine different counties and 27 cities throughout the state. During these events, 13 470 vaccinations were administered to 10 047 unique individuals. Among those vaccinated, 5645 (56.2%) were African American, 2547 (25.3%) were White, and 1068 (10.6%) were Hispanic (Table 1).

Vaccination disparities improved markedly within one month of HEST activities among individuals 65 years or older. Specifically, there was a decrease in the number of counties with a disparity of 10 percentage points or more in the proportion of vaccines

TABLE 1— Number of COVID-19 Doses Administered at HEST Community Vaccination Clinics, by Month and Race/Ethnicity: 10 US Counties, January–April 2021

		Race/Ethnicity, No.					
Clinic Month	**Dose Type**	**African American**	**White**	**Hispanic**	**Other**	**Missing**	**Total No.**
January	First dose	412	141	20	19	311	903
February	First dose	1 865	804	79	67	145	2 960
February	Second dose	489	219	25	14	23	770
March	First dose	3 072	1 503	942	135	106	5 758
March	Second dose	1 316	596	13	13	35	1 973
April	First dose	296	99	27	3	1	426
April	Second dose	483	153	24	20	0	680
Total first dose		5 645	2 547	1 068	224	563	10 047
Total second dose		2 288	968	62	47	58	3 423

Note. HEST = health equity strike team.

administered to people aged 65 years or older relative to the minority population. On March 1, 2021, seven counties were in this category with respect to African American populations (Table 2). By April 1, 2021, no counties were in this category. Among the counties with the greatest disparities, County A saw the largest change (8.8 percentage points; −15.8% in March to −7.0% in April). The statewide disparities in population composition and vaccine distribution seen among African Americans decreased from −3.0% to −1.7%.

Similar analyses were conducted for the Hispanic population. Whereas there were no counties with a 10-percentage-point deficit or higher with respect to Hispanic populations, the statewide disparity changed from −0.5% to 0.2% (Table 3). The counties with the greatest disparities in March were mostly nonmetropolitan counties with relatively small urban populations (as indicated by Rural–Urban Continuum Codes).[4]

A total of 33 educational videos (11 of which were in Spanish and two in Marshallese) were created to address vaccine hesitancy among minority communities. These videos were viewed a total of 4815 times during the evaluation period.

ADVERSE EFFECTS

HESTs were not made aware of any adverse events.

SUSTAINABILITY

Currently, there are federal grant opportunities available to address COVID-19 health disparities. The Office of Health Equity submitted a proposal and requested funds to sustain HESTs for two years. These funds would be used to maintain a workforce of 20 to 40 contractors to staff the clinics. In addition, HESTs will seek continued assistance from volunteer organizations.

PUBLIC HEALTH SIGNIFICANCE

Our evaluation highlights the efforts of HESTs in reducing COVID-19 vaccine disparities. Ideally, the distribution of vaccine should mirror the population composition. The goal of the intervention described here was to improve access by conducting vaccination events in largely rural and minority communities. HESTs were instrumental in initiating and completing the COVID-19 vaccination series within the targeted communities. Ensuring equitable vaccine distribution is critical given that

TABLE 2— **Comparison of COVID-19 Vaccination Distributions With Population Compositions Among Individuals Aged 65 Years or Older, by Race: 10 US Counties, March 1, 2021, vs April 1, 2021**

		Population Composition		Vaccine Distributed March 1, 2021			Vaccine Distributed April 1, 2021		
	Rural–Urban Continuum Code	White (%)	African American (%)	White (%)	African American (%)	Disparity (Percentage Points)	White (%)	African American (%)	Disparity (Percentage Points)
State of Arkansas		87.7	10.6	84.4	7.6	−3.0	81.6	8.9	−1.7
County A	7	50.4	48.5	55.2	32.8	−15.7	48.4	41.6	−6.9
County B	6	48.8	50.4	58.4	35.7	−14.7	47.9	43.8	−6.6
County C	6	59.8	39.2	65.1	28.3	−10.9	60.5	33.4	−5.8
County D	4	74.5	24.7	75.9	13.9	−10.8	69.3	18.9	−5.8
County E	7	74.5	24.9	82.5	14.3	−10.6	73.5	21.5	−3.4
County F	7	74.4	24.6	78.4	14.3	−10.3	73.6	18.0	−6.6
County G	7	65.3	33.4	71.5	23.2	−10.2	62.2	30.9	−2.5
County H	2	73.0	25.2	74.5	15.4	−9.8	70.7	18.1	−7.1
County I	6	81.0	17.9	84.2	8.5	−9.4	79.4	13.0	−4.9
County J	7	72.5	27.3	73.4	18.2	−9.1	70.0	18.5	−8.8

Note. Rural–Urban Continuum Codes are as follows: 1 = counties in metropolitan areas of 1 million population or more; 2 = counties in metropolitan areas of 250 000–1 million population; 3 = counties in metropolitan areas of less than 250 000 population; 4 = urban population of 20 000 or more, adjacent to a metropolitan area; 5 = urban population of 20 000 or more, not adjacent to a metropolitan area; 6 = urban population of 2500–19 999, adjacent to a metropolitan area; 7 = urban population of 2500–19 999, not adjacent to a metropolitan area; 8 = completely rural or less than 2500 urban population, adjacent to a metropolitan area; 9 = completely rural or less than 2500 urban population, not adjacent to a metropolitan area.

TABLE 3— Comparison of COVID-19 Vaccination Distributions With Population Compositions Among Individuals Aged 65 Years or Older, by Ethnicity: 10 US Counties, March 1, 2021, vs April 1, 2021

		Population Composition		Vaccine Distributed March 1, 2021			Vaccine Distributed April 1, 2021		
	Rural–Urban Continuum Code	Non-Hispanic (%)	Hispanic (%)	Non-Hispanic (%)	Hispanic (%)	Disparity (Percentage Points)	Non-Hispanic (%)	Hispanic (%)	Disparity (percentage points)
State of Arkansas		98.1	1.9	88.9	1.4	−0.5	86.5	2.1	+0.2
County 1	6	89.8	10.2	81.6	2.9	−7.3	71.8	5.2	−5.0
County 2	7	96.7	3.3	97.0	0.5	−2.8	95.2	2.2	−1.1
County 3	2	96.4	3.6	87.7	1.1	−2.5	83.8	2.3	−1.3
County 4	7	95.9	4.1	90.8	2.0	−2.1	86.3	3.9	−0.2
County 5	6	96.9	3.1	88.0	1.3	−1.8	83.4	2.1	−1.0
County 6	6	97.7	2.3	92.2	0.5	−1.8	87.0	1.4	−0.9
County 7	7	98.0	2.0	85.9	0.5	−1.5	85.8	0.9	−1.1
County 8	6	95.4	4.6	93.2	3.1	−1.5	90.2	4.2	−0.4
County 9	2	95.7	4.3	91.7	3.1	−1.2	89.4	4.6	+0.3
County 10	9	98.6	1.4	89.5	0.4	−1.0	86.7	0.6	−0.8

Note. Rural–Urban Continuum Codes are as follows: 1 = counties in metropolitan areas of 1 million population or more; 2 = counties in metropolitan areas of 250 000–1 million population; 3 = counties in metropolitan areas of less than 250 000 population; 4 = urban population of 20 000 or more, adjacent to a metropolitan area; 5 = urban population of 20 000 or more, not adjacent to a metropolitan area; 6 = urban population of 2500–19 999, adjacent to a metropolitan area; 7 = urban population of 2500–19 999, not adjacent to a metropolitan area; 8 = completely rural or less than 2500 urban population, adjacent to a metropolitan area; 9 = completely rural or less than 2500 urban population, not adjacent to a metropolitan area.

minority populations have been disproportionately affected by the pandemic.

Ensuring access is one part of a multipronged approach needed to address vaccine disparities. Providing education to those who may be vaccine hesitant is equally important. Rates of vaccine hesitancy have been shown to be higher among racial and ethnic minority groups than among Whites.[5] Several factors account for the increased vaccine hesitancy among these groups, with the most notable being mistrust and concerns about side effects.[5,6] The videos created by the Office of Health Equity featured prominent members of the community who are seen as trusted leaders. These individuals advocated for and emphasized the overall safety of the vaccines in addition to expressing trust in the scientists who developed them. The Arkansas Department of Health maintains a YouTube channel where these videos are posted. States and programs aiming to reduce disparities might consider this approach as a means of addressing vaccine disparities. AJPH

ABOUT THE AUTHORS

Austin Porter and Namvar Zohoori are with the Fay W. Boozman College of Public Health, University of Arkansas for Medical Sciences, and the Arkansas Department of Health, Little Rock. Samantha Wells and George Pro are with the Fay W. Boozman College of Public Health, University of Arkansas for Medical Sciences. Chimfumnanya Smith and Michelle R. Smith are with the Arkansas Department of Health.

CORRESPONDENCE

Correspondence should be sent to Austin Porter, DrPH, MPH, 4301 W Markham Slot 820-12, Little Rock, AR 72205 (e-mail: aporter@uams.edu). Reprints can be ordered at http://www.ajph.org by clicking the “Reprints” link.

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CONTRIBUTORS

A. Porter, S. Wells, and C. Smith drafted the article and analyzed the data. N. Zohoori, G. Pro, and M. R. Smith provided significant revisions. S. Wells, C. Smith, and M. R. Smith conceptualized and coordinated the intervention.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

The institutional review board of the University of Arkansas for Medical Sciences designated this study as non–human participant research.

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HIV Preexposure Prophylaxis Care Continuum Among Individuals Receiving Medication for Opioid Use Disorder, South Carolina, 2020–2021

Jamila Johnson, MS, Mirinda Ann Gormley, PhD, MSPH, Susanne Bentley, DO, Carrie Baldwin, FNP, Michelle Bublitz, MSN, APRN, Smith F. Heavner, RN, MPH, Prerana Roth, MD, MPH, and Alain H. Litwin, MD, MPH

We implemented the HIV preexposure prophylaxis (PrEP) care continuum among individuals receiving medication for opioid use disorder (MOUD). We screened HIV-negative MOUD participants for PrEP eligibility by assessing injection drug use risk factors and sexual behaviors. Implementation of the PrEP care continuum was challenging; less than a third of MOUD participants were aware of PrEP, and very few initiated PrEP. Findings should promote the development of effective interventions to increase engagement in PrEP during MOUD treatment. (*Am J Public Health*. 2022;112(1):34–37. https://doi.org/10.2105/AJPH.2021.306566)

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The spread of HIV has been associated with a rise in injection drug use among individuals who misuse opioids.[1] People who inject drugs (PWID) are at a greater risk for contracting HIV when sharing needles, syringes, or other injection equipment and participating in sexual behaviors such as having sex while intoxicated and having condomless sex. Antiretroviral preexposure prophylaxis (PrEP) taken daily can effectively reduce PWID's risk of acquiring HIV.[2,3] Although the US Department of Health and Human Services recommends PrEP be offered to PWID along with other harm-reduction services (e.g., medication for opioid use disorder [MOUD], syringe services programs),[3] little is known about the PrEP care continuum in this high-risk population.[4] Most researchers describe progression of the PrEP care continuum among populations of men who have sex with men (MSM)[5]; however, no studies have reported the implementation of the PrEP care continuum among individuals receiving MOUD.

INTERVENTION

Three authors (A. H. L., S. F. H., and P. R.) developed an eligibility screener containing 45 questions, adapting questions from the HIV Incidence Risk Index for MSM[6] and the Assessment of the Risk of Contracting HIV for Injection Drug Use provided in the 2017 Centers for Disease Control and Prevention HIV PrEP Provider Supplement.[7] Information for these scales can be found in Tables C–E (available as a supplement to the online version of this article at http://www.ajph.org).

Additional questions collected information for the HIV PrEP care continuum,[5] which is made up of nine steps:

1. Identify individuals at highest HIV risk,
2. Enhance self-perceived HIV risk awareness,
3. Raise PrEP awareness,
4. Facilitate PrEP access,
5. Link to PrEP care,
6. Prescribe PrEP,
7. Initiate PrEP,
8. Adhere to PrEP, and
9. Retain in PrEP care.

PLACE AND TIME

We assessed PrEP eligibility in all patients seen between June 2, 2020, and February 2, 2021. The Prisma Health Recovery Clinic is a facility that offers MOUD in Greenville, South Carolina. An interdisciplinary team helps facilitate many services, including counseling, peer recovery coaching, and medication assistance.

PERSON

Consenting HIV-negative individuals aged 18 years and older with a diagnosis of opioid use disorder (determined using criteria from the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* [Washington, DC; American Psychiatric Association; 2013]) were eligible for MOUD if they were willing to engage in primary care and adhere to program policies. Individuals were eligible for PrEP if they met any of the following criteria: (1) vaginal or anal sexual intercourse with two or more partners in the past six months without using a condom or unsure about condom use, (2) HIV Incidence Risk Index for MSM score of 9 or higher, or (3) assessment of the Risk of Contracting HIV-Injection Drug Use Risk Index score of 46 or higher.

PURPOSE

The objective of this study was to assess PrEP eligibility criteria and implementation of the PrEP care continuum for individuals in the MOUD program.

IMPLEMENTATION

Before June 2, 2020, PrEP eligibility was not assessed and PrEP was not offered to individuals in the Prisma Health MOUD program. We assessed PrEP awareness with the questions "Have you ever heard of HIV PrEP (yes/no)," and "Have you ever been prescribed PrEP? (yes/no)." We determined interest in PrEP with the question "Would you be interested in starting PrEP (yes/no)." We did not use any questions to assess access to PrEP or linkage to PrEP care, as clinicians conducting the screener also prescribed PrEP.

We extracted information for the final stages of the PrEP care continuum from the patient chart. We considered patients who were eligible and interested as having been prescribed PrEP if their clinician wrote a prescription for PrEP during the appointment. We determined PrEP initiation by assessing whether an individual retrieved the PrEP prescription at the pharmacy. We considered an individual adherent to medication if they picked up their prescription at the pharmacy each month for three months, and we considered an individual retained in treatment if they arrived for their follow-up appointment for PrEP at three months. All patients were seen weekly, biweekly, or monthly based on MOUD stability.

We used descriptive statistics to describe PrEP eligibility in the MOUD population and show progression through the PrEP care continuum. We performed all statistical analysis using SAS version 9.4 (SAS, Cary, NC).

EVALUATION

Of the 140 individuals assessed for eligibility, 83 (59.3%) met at least one of the three eligibility criteria for PrEP. Most were eligible owing only to their Assessment of the Risk of Contracting HIV-Injection Drug Use score (91.6%), few were eligible because of sexual behaviors (18.1%), and 9.6% were eligible because of both their Assessment of the Risk of Contracting HIV-Injection Drug Use score and sexual behaviors. No individuals were eligible because of a high MSM score. Additional characteristics for the overall cohort can be found in Tables A and B (available as a supplement to the online version of this article at http://www.ajph.org).

ADVERSE EFFECTS

Figure 1 illustrates the implementation of the PrEP care continuum for individuals in the MOUD program. Less than a third (30.1%) had heard of PrEP before their appointment, no one reported previous use of PrEP, and only one individual stated that they were not sure if they had ever taken PrEP. Although 18.1% of the population were interested in PrEP, only six (7.2%) were prescribed PrEP during their appointment. Only two initiated PrEP, but neither was adherent or retained in PrEP care.

Half of the six individuals who received a PrEP prescription never arrived to the pharmacy to pick up the medication, and one arrived but was unable to fill the prescription because of lack of financial aid. Neither of the two individuals who initiated PrEP returned to the pharmacy to refill the prescription after one month; one discontinued the medication because of adverse side effects (e.g., headache), and the other dropped out of the MOUD program.

SUSTAINABILITY

To our knowledge, no previous studies have investigated the PrEP care continuum in a population receiving MOUD, yet half of the current population was eligible for PrEP. Adherence and retention to PrEP in this study were low, whereas results of previous studies have shown higher adherence and retention. This illustrates the PrEP care continuum in specific clinical settings (e.g., sexual health clinics, sexually transmitted infection and HIV centers, lesbian, gay, bisexual, and transgender [LGBT] clinics). The differences in these results may be attributed to motivation, as the primary motivation of individuals seeking care at sexually transmitted infections clinics, HIV centers, and LGBT clinics is to safeguard their sexual health. By contrast, individuals with opioid use disorder prioritize treatment with MOUD and may not be willing to engage in additional care that does not directly address their opioid use disorder.

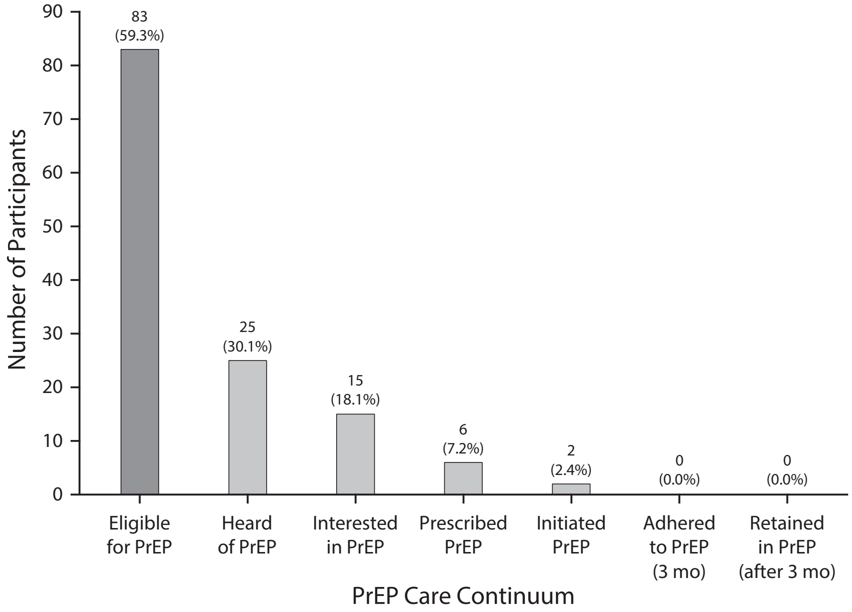

FIGURE 1— The Preexposure Prophylaxis (PrEP) Care Continuum Among PrEP Eligible Individuals Receiving Medication for Opioid Use Disorder: South Carolina, June 2020–February 2021

Note. Study size was n = 83 participants. The figure shows the proportion who were eligible of all individuals assessed (n = 140).

However, findings of this study show that clinicians would be wise to take advantage of the frequency of MOUD visits to provide PrEP to this high-risk population. Screening and implementing the PrEP care continuum to patients receiving MOUD may increase the number of opportunities for clinicians to promote awareness of a patient's HIV risk through regular discussions about PrEP and HIV risk factors and engage patients in PrEP during follow-up MOUD visits. Lack of adherence and retention in this study highlights a need for additional research to understand how to improve PrEP care during MOUD treatment.

PUBLIC HEALTH SIGNIFICANCE

To our knowledge, this is the first study to illustrate the progression of the PrEP care continuum for patients receiving MOUD. These findings support the need for improvement in PrEP education and clinician engagement to increase PrEP interest, uptake, and adherence in this high-risk population. Future research should identify barriers along the PrEP care continuum that are unique to those receiving MOUD. Additional efforts should be directed to initiating PrEP in MOUD programs to mitigate high-risk behaviors and reduce the spread of HIV among individuals with opioid use disorder. AJPH

ABOUT THE AUTHORS

Jamila Johnson, Carrie Baldwin, Michelle Bublitz, Smith F. Heavner, Prerana Roth, and Alain H. Litwin are with the Addiction Research Center, Prisma Health, Greenville, SC. Mirinda Ann Gormley is with the Department of Public Health Services, Clemson University, Clemson, SC. Susanne Bentley is with the Department of Medicine, University of South Carolina School of Medicine, Greenville.

CORRESPONDENCE

Correspondence should be sent to Mirinda Ann Gormley, Prisma Health Department of Emergency Medicine, 701 Grove Rd, Greenville, SC 29605 (e-mail: mirinda.gormley2@prismahealth.org). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

J. Johnson and M. A. Gormley conceptualized the research question and study hypotheses and conducted the data extraction from eligible patient charts. M. A. Gormley performed the data analysis and presentation of the results. S. Bentley provided expert feedback and revisions that guided the layout of the article. C. B. Baldwin, M. Bublitz, and A. H. Litwin used the assessment tool to assess patients and collected data. S. F. Heavner, P. Roth, and A. H. Litwin developed the assessment tool for determining eligibility for HIV PrEP. All authors provided substantial feedback and contributions during the writing and editing processes and had final responsibility for the decision to submit for publication.

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Note. The contents of this work are solely the responsibility of the authors.

CONFLICTS OF INTEREST

A. H. Litwin has served on advisory boards for Merck Pharmaceuticals, AbbVie, and Gilead Sciences and has received research grants from Merck Pharmaceuticals and Gilead Sciences. No other authors have any conflicts of interest related to this work to declare.

HUMAN PARTICIPANT PROTECTION

This project was reviewed by the Prisma Health institutional review board and determined not to meet the criteria for human participant's research.

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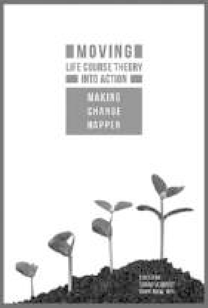

Accuracy of Case-Based Seroprevalence of SARS-CoV-2 Antibodies in Maricopa County, Arizona

Megan Jehn, PhD, MHS, Urvashi Pandit, DO, MPH, MBS, Susanna Sabin, PhD, Camila Tompkins, MPH, Jessica White, DrPH, MS, Erin Kaleta, PhD, Ariella P. Dale, PhD, MPH, Heather M. Ross, PhD, DNP, J. Mac McCullough, PhD, MPH, Susan Pepin, MD, MPH, Katherine Kenny, DNP, RN, ANP-BC, Heidi Sanborn, DNP, RN, CNE, Natalie Heywood, MSN-Ed, BSN, RN, Amy H. Schnall, MPH, Timothy Lant, PhD, and Rebecca Sunenshine, MD

We conducted a community seroprevalence survey in Arizona, from September 12 to October 1, 2020, to determine the presence of antibodies to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). We used the seroprevalence estimate to predict SARS-CoV-2 infections in the jurisdiction by applying the adjusted seroprevalence to the county's population. The estimated community seroprevalence of SARS-CoV-2 infections was 4.3 times greater (95% confidence interval = 2.2, 7.5) than the number of reported cases. Field surveys with representative sampling provide data that may help fill in gaps in traditional public health reporting. (*Am J Public Health*. 2022;112(1):38–42. https://doi.org/10.2105/AJPH.2021.306568)

Although vaccination programs against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) continue to expand in scope, an unknown proportion of individuals in the United States continue to rely upon natural postinfection immunity for protection from reinfection. Reliable estimates of the number of people who have been infected with SARS-CoV-2 are therefore of substantial value for public health practice.

Traditional public health reporting may undercount COVID-19 cases.[1] Serological surveys to detect anti-SARS-CoV-2 antibodies can provide an estimate of the true population prevalence of past infection, including those missed by traditional public health reporting, because of asymptomatic infections for which health care or testing was not sought, or symptomatic infections in persons who did not seek care or on whom SARS-CoV-2 testing was not performed.[2] However, most previous US serosurveys of SARS-CoV-2 infection have examined the prevalence of SARS-CoV-2 antibodies in convenience samples or high-risk populations, which do not provide an accurate estimate of the prevalence of SARS-CoV-2 infection in a target population.[3] Accurate estimates of the cumulative incidence of SARS-CoV-2 infection require minimally biased, population-based seroprevalence studies.

INTERVENTION

We used a 2-stage cluster probabilistic sampling design to conduct a community-level seroprevalence survey using the Community Assessment for Public Health Emergency Response (CASPER) toolbox from the US Centers for Disease Control and Prevention (CDC), a validated method for drawing a random sample of the population during public health emergencies.[4] Census blocks were randomly selected with probability proportional to the number of occupied households (per 2010 US Census) without substitution (for methodology, see Appendix A, available as a supplement to the online version of this article at http://www.ajph.org). Household sampling was conducted in the field to draw a systematic sample of households within each census block. Selected households were approached and invited to participate in the serosurvey, which consisted of a standardized household questionnaire and blood sample for serology. More than 300 field volunteers were recruited and trained including Spanish speakers, nurses, public health staff, and student volunteers from academic programs that provide disciplinary attention to concepts of institutional and structural racism and bias and their impact on underserved and underrepresented communities.

We used a Roche Elecsys Anti-SARS-CoV-2 S assay to determine the presence of antibodies to SARS-CoV-2. This assay uses spike protein (total immunoglobulin) as the antigen for the detection of antibodies and has a reported specificity of 99.5% and sensitivity of 99.8%.[5]

PLACE AND TIME

The serosurvey was conducted in Maricopa County, Arizona, between September 12 and October 1, 2020, and excluded persons who were living on tribal lands or in congregate settings. Ninety-two percent of all reported cases in the county occurred within 12 weeks of the survey (see Appendix B, available as a supplement to the online version of this article at http://www.ajph.org, for sampling period).

PERSON

A total of 791 households were approached across 30 sampling blocks. Of the 587 households where contact was made, 173 households agreed to participate, resulting in a cooperation rate of 29.5%. A total of 260 persons from 169 households consented to serology testing. Compared with census data for the county, participants differed in terms of age distribution, language spoken at home, and household size (Table 1).

PURPOSE

This serological survey was conducted to detect the presence of anti–SARS-CoV-2 antibodies to estimate the true population prevalence of past infection and assess the accuracy of case-based surveillance.

IMPLEMENTATION

The intervention included both a serological sample obtained from all consenting household members aged older than 6 years and a questionnaire administered to the self-identified head of household or delegate. The questionnaire included questions about household and demographic characteristics, chronic medical conditions, recent illnesses and associated symptoms, previous testing for SARS-CoV-2, mental and financial impacts from the pandemic, and occupational exposures. Blood samples were collected onsite using standard venipuncture techniques, and samples were centrifuged in the field within 30 to 120 minutes of collection.

EVALUATION

Overall, 30 (11.5%) of 260 blood samples collected from 169 households were seropositive. The overall weighted seroprevalence of SARS-CoV-2 antibodies across Maricopa County was 14.0% (95% confidence interval [CI] = 7.2%, 24.0%) through August 27, 2020, in persons aged 7 years or older, corresponding to an estimated 589 156 (95% CI = 302 994, 1 009 982) individuals having been infected with SARS-CoV-2 through the time of the survey. As of September 9, 2021, a total of 136 193 cases of SARS-CoV-2 infection had been confirmed by conventional testing strategies and reported in Maricopa County resulting in a 4.3-fold difference (95% CI = 2.2, 7.5) between the estimated number of infections based on seroprevalence and reported case counts in line with other population-based estimates.[6–8]

As compared with seronegative households, seropositive households were more likely to report a non-English language spoken in the home (weighted % = 37.5%; 95% CI = 18.3%, 61.7% vs weighted % = 16.5%; 95% CI = 9.1%, 27.9%; *P* = .02) and more likely to report that an occupant had been told by a health professional that they previously had COVID-19 compared with seronegative households (weighted % = 45.8%; 95% CI = 26.1%, 66.8% vs weighted % = 4.0%; 95% CI = 1.7%, 9.2%; *P* = <.001; Table 2). Mean household size was slightly larger for seropositive households as compared with seronegative households, although this was not statistically significant (3.1 vs 2.4; *P* = .18).

Among households with anti–SARS-CoV-2 antibodies, 59.4% (95% CI = 38.3%, 77.5%) reported a history of COVID-19–like illness. Only 54.1% (95% CI = 21.2%, 83.8%) of those households who reported illness had been tested for SARS-CoV-2 infection. The most commonly reported reasons for not being tested were concerns about the cost (24%), uncertainty about where to get a test (24%), inaccessibility of testing sites (19%), difficulty scheduling (19%), concerns about eligibility for testing given reported scarcity (5%), and concerns about citizenship status (2%).

Limitations include the potential for self-selection bias, whereby some individuals (e.g., those with previous symptoms or a previous positive SARS-CoV-2

TABLE 1— Unweighted Demographic Characteristics of Survey Participants With a SARS-CoV-2 Serology Test Result Compared With 2019 Postcensal Estimates for the Overall Catchment Area: Maricopa County, AZ, September 12–October 1, 2020

	Unweighted Participants	Weighted Sample	Catchment Area[a]
Overall no.	260	4 090 940	4 485 414
Individual characteristics (n = 260)			
Age group, y, no. (%)			
5–19[b]	20 (7.7)	881 189 (21.5)	895 544 (20.0)
20–44	80 (30.8)	1 493 193 (36.5)	1 539 171 (34.3)
45–64	87 (33.5)	1 051 372 (25.7)	1 078 113 (24.0)
≥ 65	73 (28.1)	662 732 (16.2)	696 467 (15.5)
Gender, no. (%)			
Male	105 (40.4)	2 016 833 (49.3)	2 217 116 (49.4)
Female	154 (59.5)	2 072 061 (50.7)	2 268 298 (50.6)
Household characteristics (n = 169)			
Household size, mean	2.59	2.50	2.75
Non-English language spoken at home, no. (%)	35 (20.7)	1 278 191 (28.8)	1 210 791 (26.9)
Urbanicity,[c] no. (%)			
Urban	166 (98.3)	3 951 848 (96.5)	3 725 506 (97.6)
Rural	3 (1.7)	143 183 (3.5)	91 611 (2.4)

Note. SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

[a] Age, gender, household size, and language spoken at home were obtained from American Community Survey 2019 1-year estimates.
[b] Our sample included children aged > 6 years, and census data are only available for children aged 5–19 years.
[c] Urbanicity was estimated using American Community Survey 2010 data.

infection) may have elected to participate in no-cost serology testing at a higher rate than the general population. Second, our estimate of exposure to SARS-CoV-2 infection is likely an underestimate of the true infection rate given that the sensitivity of SARS-CoV-2 immunoassays varies depending on the severity of the initial infection and the timing of collection.[9] However, the Roche assay has been shown to be highly sensitive (91.4%) up to 8 months after asymptomatic or mildly symptomatic infection with SARS-CoV-2.[10] Third, because the CASPER methodology is designed to collect household-level data, we could not correlate individual-level illness history with individual serological results.

ADVERSE EFFECTS

We did not observe any adverse effects.

SUSTAINABILITY

In the absence of national coordination, state and local health officials have turned to a variety of sampling approaches to determine SARS-CoV-2 seroprevalence, which may under- or overestimate seroprevalence. National coordination would enable better resource utilization, improve efficiency, foster data harmonization, and facilitate formation of best practices.

PUBLIC HEALTH SIGNIFICANCE

Confirmed COVID-19 case counts do not capture the total burden of the pandemic. Only 54% of households in this sample with COVID-19–like illness reported that family members were tested, suggesting that testing was not widely accessible, or testing was not perceived to be affordable to a significant proportion of the community. Our findings may help explain why persons who are members of minority, rural, and other underserved communities are often undercounted in traditional case-based public health surveillance. Our study and others[11] have shown that door-to-door COVID-19

TABLE 2— Weighted Demographic Characteristics of Households With and Without SARS-CoV-2 Antibodies: Maricopa County, AZ, September 12–October 1, 2020

	Households With SARS-CoV-2 Antibodies[a] (n = 23)		Households Without SARS-CoV-2 Antibodies (n = 146)		
	No.	Weighted Proportion (95% CI)	No.	Weighted Proportion (95% CI)	P[b]
Household characteristic					
Non-English language spoken in home	8	37.5 (18.3, 61.7)	27	16.5 (9.1, 27.9)	.021
Illness history					
COVID-19–like Illness reported in household[c]	14	59.4 (38.3, 77.5)	39	23.2 (15.6, 33.1)	.002
Proportion of households with symptomatic family members who were tested when ill	10	54.1 (21.2, 83.8)	16	37.1 (18.0, 61.4)	.038
Medical history					
Presence of chronic conditions in household[d]	10	50.0 (25.9, 74.1)	67	51.6 (39.7, 63.3)	.91
Previously tested for SARS-CoV-2					
None	11	43.7 (24.2, 65.5)	97	66.4 (54.9, 76.2)	.09
Swab test	11	52.5 (31.6, 72.5)	44	31.4 (21.8, 42.9)	.1
Positive test reported in swab-tested household members	9	76.2 (35.3, 94.9)	4	7.1 (2.8, 16.9)	< .001
Household member ever told by physician that they had COVID-19	10	45.8 (26.1, 66.8)	7	4.0 (1.7, 9.2)	< .001
Work industry of immediate household members					
Health care	4	15.0 (5.2, 36.2)	19	10.5 (7.2, 15.0)	.48

Note. CI = confidence interval; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

[a] Seropositive households were defined as households with at least 1 participating household member who was antibody positive.
[b] Characteristics of seropositive and seronegative households were compared using the Pearson χ^2 test with design-based correction for categorical variables and Wald test (F ratio) for continuous variables.
[c] An illness was categorized as compatible with COVID-19 if participants responded "yes" to the following question: "Since January 1, 2020, has anyone in your household experienced an illness with fever, cough, difficulty breathing/shortness of breath, and/or loss of taste or smell?"
[d] Chronic conditions defined as diabetes, pregnancy, chronic lung disease, moderate to severe asthma, obesity, chronic kidney disease, serious heart condition, or immunocompromised state (including cancer, HIV, transplants, and immunosuppressive medications).

interventions help reach groups disproportionately affected by COVID-19.

The COVID-19 pandemic is strongly shaped by deep social disparities, adverse living and working conditions, and structural inequities that drive household and occupational transmission opportunities and access to testing and medical care.[12] The disproportionate impact of COVID-19 that we observed in non–English-speaking households highlights the importance of tailoring communication strategies to the cultures and languages of local communities. The finding that a significant proportion of households experiencing COVID-19 symptoms did not seek testing also suggests a need to engage communities to better inform COVID-19 decisions about how to reduce disparities in the allocation of publicly available testing and vaccination resources. Field surveys with representative sampling provide data that may help fill in gaps in traditional public health reporting to better contextualize and inform COVID-19 mitigation strategies.

ABOUT THE AUTHORS

Megan Jehn and Camila Tompkins are with the School of Human Evolution and Social Change, Arizona State University (ASU), Tempe. Urvashi Pandit, Rebecca Sunenshine, and Jessica White are with the Maricopa County Department of Public Health, Phoenix, AZ. Susanna Sabin is with the Center for Evolution and Medicine, ASU. Erin Kaleta is with the Department of Laboratory Medicine and Pathology, Mayo Clinic, Scottsdale, AZ. Ariella P. Dale is with the Centers for Disease Control and Prevention (CDC) assigned to Maricopa County Department of Public Health. Heather M. Ross, Katherine Kenny, Heidi Sanborn, and Natalie Heywood are with the Edson College of Nursing and Health Innovation, ASU. J. Mac McCullough is with the College of Health Solutions, ASU. Susan Pepin is with Knowledge Enterprise, ASU. Amy H. Schnall is with the National Center for Environmental Health, CDC, Atlanta, GA. Timothy Lant is with the Biodesign Institute, ASU.

CORRESPONDENCE

Correspondence should be sent to Megan Jehn, Arizona State University, School of Human Evolution and Social Change, Mail Code: 2402, Tempe, AZ 85287-2402 (e-mail: megan.jehn@asu.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

M. Jehn contributed to conceptualization, design of the study, data analysis, and original draft preparation. U. Pandit contributed to design of the study and supervision of field teams. S. Sabin contributed to design of the study, supervision of field teams, data programming, and validation. C. Tompkins contributed to supervision and data curation. J. White contributed to design of the study and data curation. E. Kaleta performed laboratory analysis of samples. H. Ross, S. Pepin, K. Kenny, H. Sanborn, and N. Heywood supervised the field teams. J. McCullough contributed to data analysis, methodology, and validation. A. H. Schnall, A. Dale, and T. Lant contributed to methodology. R. Sunenshine contributed to conceptualization and design of the study. All authors reviewed and edited the draft and provided final approval of the version to be published.

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CONFLICTS OF INTEREST

J. McCullough serves as the Health Economist for the Maricopa County Department of Public Health.

HUMAN PARTICIPANT PROTECTION

The Arizona State University institutional review board reviewed the study and declared it to be exempt.

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Prioritizing COVID-19 Contact Tracing During a Surge Using Chatbot Technology

Brady D. Johnson, BS, Meg Wall Shui, MPH, Kiana Said, MPH, Alejandro Chavez, BS, and Darpun D. Sachdev, MD

See also Kapadia, p. 12.

When COVID-19 cases surge, identifying ways to improve the efficiency of contact tracing and prioritize vulnerable communities for isolation and quarantine support services is critical. During a fall 2020 COVID-19 resurgence in San Francisco, California, prioritization of telephone-based case investigation by zip code and using a chatbot to screen for case participants who needed isolation support reduced the number of case participants who would have been assigned for a telephone interview by 31.5% and likely contributed to 87.5% of Latinx case participants being successfully interviewed. (*Am J Public Health*. 2022;112(1):43–47. https://doi.org/10.2105/AJPH.2021.306563)

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In this era of effective vaccines and increased federal investment, health departments have reduced staffing while also seeking to retain a workforce with the capacity to contact trace COVID-19.[1] However, the rapidity of resurgence and testing delays as well as the low proportion of case participants naming contacts pose major challenges to program effectiveness.[2–5] Ensuring that vulnerable populations receive the ancillary services to safely isolate remains a critical health equity goal. Identifying best practices on how to optimally use staff and technology is necessary to maximize efficiency and ensure the capacity to support isolation.

INTERVENTION

In response to a surge in cases in fall 2020, the San Francisco Department of Public Health (SFDPH), in California, implemented a tiered prioritization strategy that focused telephone-based case investigation on certain zip codes while using a secure, confidential chatbot tool to maintain ongoing outreach to all case participants and screen for those who needed isolation support. We conducted this work as part of SFDPH's COVID-19 surveillance.

The Virtual Agent is an automated, interactive chatbot integrated with CalCONNECT, California's statewide case management and contact-tracing platform. Upon health department receipt of the lab result, we invited case participants to complete the chatbot survey through a unique link sent via text message. Available in English and Spanish, the Virtual Agent requires case participants to confirm their date of birth and zip code; it then educates individuals about their isolation period and asks about their ability to isolate, symptoms, spread settings, affiliation with congregate settings, and demographics. The Virtual Agent also elicits close contacts, thus allowing contact notification to occur without needing to conduct a telephone interview with the case participant (Appendix A [available as a supplement to the online version of this article at http://www.ajph.org]). We saved the data the Virtual Agent collected to a MongoDB hosted in Amazon Web Services DocumentDB (Seattle, WA). This is a custom solution built by Accenture exclusively for the California Department of Public Health. Government agencies can contact the California Department of Public Health and Accenture (Samantha.Geronimo@accenture.com and Eyal.Darmon@accenture.com) about how to use this.

PLACE AND TIME

To examine this approach, we compared COVID-19 case participant interview outcomes in San Francisco by race/ethnicity during the two-month surge period (November 16, 2020–January 15, 2021) to the outcomes of the previous two, "nonsurge" months (September 1, 2020–October 31, 2020).

PERSON

This program included all COVID-19 case participants reported to the SFDPH who were assigned for case investigation. We excluded case participants with test results received 10 or more days after specimen collection and those residing in congregate living settings.

PURPOSE

Beginning in November 2020, there was a steep increase in the COVID-19 case rate, leading to more case participants identified over a two-month period than in the previous seven months combined. This surge exceeded the SFDPH's capacity to provide traditional telephone-based case investigation for all case participants, so the SFDPH focused its intensive telephone-based efforts on the zip codes with the highest case rates, which correlated with where Latinx communities are known to reside. In San Francisco, Latinx individuals represent 15% of the population but made up 40% of identified COVID-19 cases, and they are more likely to request support to isolate and have contacts test positive than any other race/ethnicity.[6,7]

IMPLEMENTATION

In November 2020, the SFDPH began sending the chatbot survey to all case participants assigned for case investigation (except those younger than 18 years because of lack of informed consent) and implemented a two-tiered prioritization schema for telephone calls. Factors informing inclusion in the high-priority tier 1 included age (younger than 18 years and 50 years and older) and residence in a priority zip code (top six zip codes based on current case rates and data regarding proportion of case participants successfully completing an interview and naming contacts). We sent tier 1 case participants the chatbot survey and made at least two telephone call attempts over two days regardless of chatbot response. We sent tier 2 case participants the chatbot survey only. In both tiers, we immediately called all chatbot respondents who indicated an inability to safely self-isolate, interviewed them, and offered them support services.

We considered an interview complete if the case participant completed or partially completed the telephone interview or responded to the chatbot and answered at least the first question regarding their ability to isolate.

We created a data set composed of cases in SQL Server Management Studio (Microsoft Corp., Redmond, WA) from public health databases and analyzed it using R software (R Foundation for Statistical Computing, Vienna, Austria). We tested statistical differences in group outcomes using the Fisher exact test.

EVALUATION

The number of case participants assigned for case investigation increased by 416% in the nonsurge compared to the surge period (2731/14 095), whereas case investigation staffing increased only 20% (64.2 vs 77.0 full-time equivalent; Table 1). During the surge period, 68.5% (9656/14 095) of case participants met tier 1 criteria, and we prioritized them for a telephone interview. We did not assign the 31.5% (4439/14 095) who met tier 2 criteria for telephone interview.

Across both tiers, we successfully sent 90.5% (11 303/12 491) of case participants aged 18 years and older the chatbot survey, and among those 37.3% (4221/11 303) responded (data not shown). Chatbot response rates were higher among White case participants than among Latinx case participants (53.6% [1423/2656] vs 31.4% [1300/4140]; $P < .001$), and higher among those aged 18 to 49 years than among those aged 50 years or older (41.3% [3501/8480] vs 25.5% [720/2823]; $P < .001$; data not shown).

Although the overall proportion of case participants interviewed decreased from 85.5% (2335/2731) to 75.7% (10 664/14 095) between periods, the percentage of Latinx case participants who completed interviews remained high (93.5% [1122/1200] during nonsurge vs 87.5% [4672/5339] during surge; Table 1). Among completed interviews, we conducted 21.0% (2236/10 664) using exclusively the chatbot, with a higher proportion of White case participants interviewed with the chatbot only compared with Latinx case participants (42.6% [976/2289] vs 8.9% [414/4672]; data not shown). The proportion of case participants interviewed within 24 hours of test receipt decreased from 76.9% (2099/2731) to 51.2% (7216/14 095) across periods. The median time from when the chatbot was sent to a response was 26 minutes.

The number of contacts identified across periods increased 210%, from 3121 to 9660, whereas the mean number of contacts named per case participant decreased from 1.35 to 0.74 (Table 1). The number of contacts named per case participant was similar between White and Latinx case participants during nonsurge (1.27 vs

TABLE 1— COVID-19 Case Investigation and Contact-Tracing Outcomes: San Francisco, CA, September 1–October 31, 2020, and November 16, 2020–January 15, 2021

	Nonsurge	Surge		
	All, No. (Column % or % of Eligible)	All, No. (Column % or % of Eligible)	Tier 1, No. (Row % or % of Eligible)	Tier 2, No. (Row % or % of Eligible)
Eligible case participants				
Total	2 731 (100.0)	14 095 (100.0)	9 656 (68.5)	4 439 (31.5)
Race/ethnicity				
White	544 (19.9)	3 115 (22.1)	1 471 (47.2)	1 644 (52.8)
Latinx	1 200 (43.9)	5 339 (37.9)	4 522 (84.7)	817 (15.3)
Other (group)[a]	987 (36.1)	5 641 (40.0)	3 663 (64.9)	1 978 (35.1)
Asian	439 (16.1)	2 512 (17.8)	1 764 (70.2)	748 (29.8)
Black or African American	136 (5.0)	698 (5.0)	545 (78.1)	153 (21.9)
Multiracial	83 (3.0)	146 (1.0)	101 (69.2)	45 (30.8)
Native American	3 (0.1)	37 (0.3)	29 (78.4)	8 (21.6)
Native Hawaiian/Pacific Islander	30 (1.1)	138 (1.0)	115 (83.3)	23 (16.7)
Other	65 (2.4)	1 164 (8.3)	744 (63.9)	420 (36.1)
Declined to state	13 (0.5)	. . .	. . .	. . .
Unknown	218 (8.0)	946 (6.7)	365 (38.6)	581 (61.4)
Case participants interviewed[b]				
Total	2 335 (85.5)	10 664 (75.7)	7 915 (82.0)	2 749 (61.9)
Race/ethnicity				
White	475 (87.3)	2 289 (73.5)	1 155 (78.5)	1 134 (69.0)
Latinx	1 122 (93.5)	4 672 (87.5)	4 083 (90.3)	589 (72.1)
Other (group)[a]	738 (74.8)	3 703 (65.6)	2 677 (73.1)	1 026 (51.9)
Case participants interviewed in 24 h				
Total	2 099 (76.9)	7 216 (51.2)	5 023 (52.0)	2 193 (49.4)
Race/ethnicity				
White	436 (80.1)	1 748 (56.1)	809 (55.0)	939 (57.1)
Latinx	1 015 (84.6)	3 022 (56.6)	2 573 (56.9)	449 (55.0)
Other (group)[a]	648 (65.7)	2 446 (43.4)	1 641 (44.8)	805 (40.7)
Case participants who named ≥ 1 contacts				
Total	1 244 (45.6)	3 629 (25.7)	3 158 (32.7)	471 (10.6)
Race/ethnicity				
White	250 (46.0)	553 (17.7)	394 (26.8)	159 (9.7)
Latinx	610 (50.8)	1 877 (35.2)	1 733 (38.3)	144 (17.6)
Other (group)[a]	384 (38.9)	1 199 (21.2)	1 031 (28.1)	168 (8.5)
Mean no. contacts named				
Total	1.35	0.74	0.96	0.27
Race/ethnicity				
White	1.27	0.46	0.68	0.27
Latinx	1.58	1.03	1.13	0.43
Other (group)[a]	1.13	0.63	0.86	0.21
Eligible contacts elicited	3 121	9 660	7 804	1 856
Contacts notified	2 639 (84.6)	7 314 (75.7)	6 215 (79.6)	1 099 (59.2)

Continued

TABLE 1— Continued

	Nonsurge	Surge		
	All, No. (Column % or % of Eligible)	All, No. (Column % or % of Eligible)	Tier 1, No. (Row % or % of Eligible)	Tier 2, No. (Row % or % of Eligible)
Investigators	64.2	77	. . .	. . .
Average cases per investigator	42.5	183.1	125.4	. . .

Note. We stratified results by race and surge period. The nonsurge period was September 1, 2020–October 31, 2020. The surge period was November 16, 2020–January 15, 2021.

[a] "Other (group)" combines those responding as Asian, Black or African American, Multiracial, Native American, Native Hawaiian/Pacific Islander, other, declined to state, and unknown.

[b] We defined interview completion by a completed or partially completed telephone interview or a response to the chatbot in which at least the first question regarding the case participant's ability to isolate was answered.

1.58) but decreased during surge (0.46 vs 1.03).

During the nonsurge period, the mean case load per case investigator per month was 42.5, which increased to 183.1 during surge (Table 1). However, when considering only tier 1 case participants assigned for telephone interview, the mean case load per case investigator during the surge was 125.4, which is 31.5% lower than the total mean case load of 183.1.

ADVERSE EFFECTS

Telephone interviews were more likely than the chatbot to yield named contacts; however, chatbot technology helped ensure that all individuals were offered isolation support services within minutes of receiving test results.

SUSTAINABILITY

Prioritization of telephone outreach by zip code and using a chatbot reduced the number of case participants who would have been assigned for telephone interview by 31.5% and likely contributed to 87.5% of Latinx case participants being successfully interviewed and more than half interviewed within a day of test results. This high percentage of completed interviews among a population at higher risk was achieved despite the number of cases increasing several fold between the nonsurge and surge periods. Given planned reductions in contact-tracing staffing, this strategy will be sustained to address future surges and disease outbreaks.

The zip code–based prioritization strategy may not be generalizable to jurisdictions where zip codes do not align as much with race/ethnicity, income, and education level. In San Francisco, more than 85% of Latinx case participants reported to the SFDPH resided in a priority zip code.

PUBLIC HEALTH SIGNIFICANCE

Given competing demands on health departments during a COVID-19 resurgence, programs could experiment with more automated models of offering timely isolation resources to vulnerable communities. Systematically integrating chatbot technology into disease investigation may improve timely outreach and modernize health departments in preparation for future disease outbreaks.

ABOUT THE AUTHORS

All authors are with the Population Health Division, San Francisco Department of Public Health, San Francisco, CA. Brady D. Johnson is also with the Department of Tropical Medicine, School of Public Health and Tropical Medicine, Tulane University, New Orleans, LA.

CORRESPONDENCE

Correspondence should be sent to Darpun D. Sachdev, MD, Population Health Division, San Francisco Department of Public Health, 356 Seventh St, San Francisco, CA 94103 (darpun.sachdev@sfdph.org). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

B. D. Johnson contributed to chatbot development and implementation and led the writing. M. Wall Shui completed the analyses. K. Said and A. Chavez contributed to chatbot implementation and assisted with the article preparation. D. D. Sachdev conceptualized and supervised the study.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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Institutional review board approval and informed consent were not required for this study because the work was conducted as part of San Francisco Department of Public Health COVID-19 surveillance.

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New Frontiers of Environmental Justice

Jonathan I. Levy, ScD, and Diana Hernández, MA, PhD

ABOUT THE AUTHORS

Jonathan I. Levy is with the School of Public Health, Boston University, Boston, MA. Diana Hernández is with the Mailman School of Public Health, Columbia University, New York, NY.

See also the New Frontiers of Environmental Justice section, pp. 48–134.

A decade ago, *AJPH* published a special supplement on environmental justice (https://ajph.aphapublications.org/toc/ajph/101/S1), with dozens of articles addressing themes such as residential proximity to hazardous facilities, expanded risk assessment frameworks that acknowledged cumulative exposures and differential vulnerability, and perspectives on community engagement, empowerment, and capacity building.

Much has changed over the past decade. The escalating burden of climate change, growing recognition of the insidiousness of racism, and political extremism have had profound influences on public health and environmental justice. Given this, we put out a call for papers on "New Frontiers of Environmental Justice," soliciting articles that address novel topics, utilize innovative methods, and reflect on approaches for addressing environmental justice in the future. In the current and subsequent issues of *AJPH*, we present articles that grapple with some of these complex questions.

This special section features complementary framing and research articles that beckon more inclusive understandings of oppression and action-oriented processes to pursue justice. For instance, Goldsmith and Bell (p. 79) explore how environmental exposures disproportionately affect the LGBTQ+ (lesbian, gay, bisexual, transgender, queer or questioning, and others) population while Collins et al. (p. 54) and Gaard (p. 57) discuss the implications of an intersectional approach within environmental justice research and policy. Relatedly, McDonald et al. (p. 50) expose toxic disparities in beauty products marketed toward people of color, including LGBTQ+ members, and call for regulatory changes within the cosmetics industry.

Some articles apply novel approaches or frameworks to address legacy environmental issues. For example, Pace et al. (p. 88) utilize geospatial data sets to evaluate racial/ethnic disparities within community water systems and domestic well areas in California. In forthcoming issues, accepted articles will point to some valuable new directions related to racial inequities in air pollution exposures, considering previously unexamined groups, using new approaches to yield more spatially resolved air quality estimates, and empowering communities to address local air quality. Other articles address the effects of cold (Ryti et al., p. 107) or heat (Schwarz et al., p. 98), important given a rapidly changing climate, with the latter study focusing on the understudied vulnerable population of homeless individuals.

Innovation needs to happen not just on research methods but also on processes and policies to ensure that overburdened communities have a seat at the table. Carrión et al. (p. 59) reinforce the importance of community-engaged research to allow for greater inclusion and better-informed research, and Bourland et al. (p. 63) emphasize that funding processes need to prioritize frontline organizations working in overburdened communities. Atencio et al. (p. 116) propose approaches for meaningful Tribal consultation related to the cumulative impacts of projects. Sullivan et al. (p. 124) argue that the Environmental Protection Agency needs to restore funding and structures to address children's environmental health given important environmental justice implications. Meanwhile, Hernández (p. 66) shifts the gauge of resilience toward the social, economic, and structural dimensions of housing after demonstrating how climate change is experienced within residential settings.

Ultimately, these articles on diverse topics reinforce the importance of an environmental justice lens to characterize susceptible and vulnerable populations and to address the effects of historic and contemporary racism. Given the direct connections between environmental justice and the disproportionate burdens from COVID-19, climate change, and other major stressors, there needs to be much broader and deeper engagement. Levy et al. (p. 69) argue that the reduced environmental health content in MPH education leaves students unprepared to address these challenges of our time. Turpin et al. (p. 75) and Guidotti and Cwikel (p. 77) reinforce this argument and emphasize that practitioners across public health need environmental health expertise to center health equity when working to create resilient and sustainable communities.

In future issues of *AJPH*, articles will continue to grapple with the central public health challenges of our time, centering issues of racial justice and health inequities. We look forward to continued innovation and increased emphasis on environmental justice.

AJPH

CORRESPONDENCE

Correspondence should be sent to Jonathan I. Levy, Professor and Chair, Department of Environmental Health, Boston University School of Public Health, 715 Albany St T4W, Boston, MA 02118 (e-mail: jonlevy@bu.edu). Reprints can be ordered at http://www.ajph.org by clicking the “Reprints” link.

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No potential or actual conflicts of interest are declared.

The Environmental Injustice of Beauty Products: Toward Clean and Equitable Beauty

Jasmine A. McDonald, PhD, Adana A. M. Llanos, PhD, MPH, Taylor Morton, MS, and Ami R. Zota, ScD, MS

ABOUT THE AUTHORS

Jasmine A. McDonald and Adana A. M. Llanos are with the Mailman School of Public Health, and the Herbert Irving Comprehensive Cancer Center, Columbia University Irving Medical Center, New York, NY. Taylor Morton is with WE ACT for Environmental Justice, New York, NY. Ami R. Zota is with the Milken School of Public Health, George Washington University, Washington, DC.

See also Levy and Hernández, p. 48.

The environmental injustice of beauty is a conceptual framework linking intersectional systems of oppression (e.g., racism, sexism, and classism) to racialized beauty practices, unequal chemical exposures, and adverse health outcomes.[1,2] This intersectional framework has been applied to multiple categories of personal care products (PCPs), including skin lighteners, hair straighteners, and fragranced menstrual and intimate care products. Although the framework originally focused on unequal chemical burdens among Black and Latina women, recent work has extended the framework to other minoritized populations.[3] New literature has also offered more robust links to adverse health outcomes[4,5] and greater characterization of harmful chemicals in products marketed to communities of color.[6]

In parallel, environmental health sciences have moved beyond a focus on the acute effects of single chemical pollutants to an emphasis on chronic exposures of complex mixtures across the life course. Exposure to potentially harmful chemicals through the use of PCPs presents a formidable challenge to the scientific community. Women report using a median of eight products daily (with some reporting up to 30 products daily),[7] providing a daily dose of a collection of chemicals that interact synergistically or antagonistically. Exposure to these chemicals has been linked to endocrine disruption, cancer, reproductive harm, and neurodevelopmental delays in children. Moreover, the effects of chemical exposures are likely magnified during critical windows.[8] For example, prenatal chemical exposures and childhood use of some hair products are associated with an earlier age at puberty—a key risk factor for breast cancer.[9,10] Thus, even before adulthood, a girl's breast cancer risk trajectory is altered by chemicals found in PCPs.

Given that the federal government vastly underregulates ingredients in PCPs, how do we secure the environmental justice of beauty for our most vulnerable communities, ensure that none are forgotten, and intervene for the betterment of communities of color?

THE NEXT 80 YEARS

In 1938, Ella Fitzgerald and the Food, Drug, and Cosmetic Act hit the stage. Fitzgerald's *A Tisket a Tasket* was number one on the music charts in 1938, and with beautifully coiffed hair she sang the hit song from the back of a bus on Abbott and Costello's 1942 movie *Ride 'Em Cowboy*. The year 1938 also marked President Franklin D. Roosevelt's signing of the Food, Drug, and Cosmetic Act, which was crafted to protect consumers from deceptively labeled or misbranded food, drugs, cosmetics, and medical devices, with far more regulation of medical devices than the other things. More than 80 years later, although Fitzgerald is an icon, the regulation of PCPs remains unchanged. Whether coiffed or all natural, Black women's hair is a priority, people of color continue the fight for "seats" at the front of the bus, and the Food, Drug, and Cosmetic Act has barely changed. However, with greater awareness of the injustice of beauty comes greater attention to the policies that affect our social norms and our health.

The Creating a Respectful and Open World for Natural Hair Act of 2020 (CROWN Act) states that persons shall not be deprived of equal rights under the law and shall not be subjected to prohibited practices based on their hair texture or hairstyle.[11] *The Daily Social Distancing Show* with Trevor Noah provided a comical (and profound) history of Black hair in which comedian Dulce Sloan highlighted the amount of chemicals Black women needed to conform to White beauty standards as well as the importance of the CROWN Act movement breaking down the stigma of Black hair in its natural state. Social media also promotes beauty culture in a targeted way via influencers. By doing so, social media platforms offer opportunities for collective organizing and changes in policies related to beauty.

The injustice of beauty is apparent in legislation, with several states enacting safer cosmetics policies. Coordinated efforts among advocacy and policy groups have led to the Safer Beauty Bill Package. The suite of four bills introduced in Congress proposes a national mandate on fragrance ingredient disclosure, a ban on 11 chemicals banned by the European Union plus the class of PFAS (per- and polyfluoroalkyl substances) chemicals, stricter regulation of the cosmetic supply chain, and greater cosmetic safety protections for women of color and salon workers.[12] Policy changes are key to beauty justice, as they are one of the only tools available to ensure equitable outcomes.

OVERLOOKED COMMUNITIES

Health inequities—defined as “differences in health that are not only unnecessary and avoidable but, in addition, are unfair and unjust”—are closely related to historical and ongoing social, economic, and environmental disadvantage.[13] Although the clean beauty movement aims to mitigate environmental inequities, key populations cannot be left behind.

LGBTQIA+ (lesbian, gay, bisexual, transgender/-sexual, queer or questioning, intersex, asexual, and all subsects) and gender nonconforming populations and their movements have traditionally struggled to gain access and recognition on critical public health issues. Let us not add “beauty injustice” to this list. Exposure to toxic products manifests differently by gender identity, gender expression, sexual orientation, and other facets of identity that factor into product selection and research on sexual and gender minorities. Although variation among sexual and gender minority individuals is becoming recognized by mainstream cultures, nonbinary gender identities have flown under the radar of marketing teams, retailers, and other producers who craft products for populations that identify solely as “male” and “female.” The assumption is that cis-women are the only users of PCPs marketed to cis-women. Research must be inclusive and consider how sexual and gender minority populations are affected by toxic products, how gender expression intersects with product usage, and if and when there is heightened vulnerability to exposure. We must ensure that sexual and gender minority communities are not overly exposed to toxins, considering the burden carried by their cis-counterparts and limited health care access.

The US multiracial population is growing. However, multiracial individuals are also often overlooked in research on toxic exposures from PCPs, and preliminary analyses suggest that their exposure patterns differ from those of individuals who adopt a monoracial identity.[7] Race is a fluid, social construct, and multiracial populations may shift their identity and self-reported racial classification over time. Moreover, youths and men of color are often removed from the conversation as well. From youths’ beauty products to mustache and beard care products, the exposures, the body burden, and the possible health effects of children and adolescents and male-identifying populations are underexplored.

RESEARCH TRANSLATION

The preponderance of the evidence suggests that interventions are needed to reduce chemical exposures during critical windows when individuals are most vulnerable. Intervention studies in adolescent Latinas suggest it is possible to reduce chemical exposures by switching to “cleaner products.”[14] The next generation of intervention studies should promote broader knowledge about toxic chemicals, improve decision making on the selection of less toxic products, address access and affordability to more desirable products, and, most importantly, implement evidence-based strategies for sustainable change. Given that barbershop behavioral interventions have proven effective in communities of color,[15] salon-based interventions are warranted. Future research studies should also aim to implement community-based participatory approaches, such as those being used in the Taking Stock Study (http://takingstockstudy.org) and the Beauty Inside Out project (https://www.weact.org/campaigns/beauty-inside-out).

THE FUTURE OF CLEAN BEAUTY

Manufacturers and retailers are increasingly aware of the potential harms of toxic chemicals to consumers. This is true in part because of the rise of consumer advocacy and the clean beauty movement, which has highlighted a need for PCPs made using safer, cleaner ingredients (excluding toxic chemicals that adversely affect human health) and transparent labeling (excluding the umbrella term "fragrance," which can contain a variety of harmful, unregulated chemicals and misleading labels with words such as "natural," "organic," "eco"). To aid consumers, some retailers, including Sephora and others, have begun marketing and distinguishing certain branded products as being clean or environmentally sustainable or planet positive.

However, the onus of achieving environmental equity should not rely solely on consumers' ability to identify toxic ingredients in PCPs. Thus, as the clean beauty movement catches on, we cannot neglect the fact that beauty has a cost—one that is unaffordable for some. As PCPs sold in the clean beauty space are costlier than their toxic counterparts (e.g., lip gloss from clean beauty brands average $14–$25, whereas brands in dollar stores are sold for $1), there might be unintended consequences, including a widening gap in inequitable chemical exposures. Such unintended consequences might be worse among the most vulnerable users (e.g., youths). This foreseeable trend will require monetary investment from manufacturers to ensure equitable access to clean products at every price point. Long-term considerations are the impact of clean beauty on corporate revenues and commitment to increasing accessibility to clean products. Furthermore, it will be important to evaluate how increasing accessibility to less toxic products affect long-term health outcomes, particularly among groups who have historically borne an unequal burden of toxic exposures. In short, there is a need to determine whether shifting patterns to the use of cleaner beauty products across population subgroups positively affects health inequities.

For many of us—irrespective of how we identify—our appearance and how we wear our hair is connected to society's hierarchy, cultural belonging, and spiritual identity. The trend of conforming to Eurocentric forms of beauty in schools, workplaces, and social settings is changing. As the natural state of the hair and bodies of people of color is increasingly embraced, beauty companies must take notice and cater to clean beauty. With environmental justice comes health equity.

CORRESPONDENCE

Correspondence should be sent to Jasmine McDonald, PhD, Department of Epidemiology, Columbia University Mailman School of Public Health, 722 West 168th St, New York, NY 10032 (e-mail: jam2319@cumc.columbia.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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J. A. McDonald sits on the Breast Cancer Prevention Partners (BCPP) Board of Directors. A. A. M. Llanos, T. Morton, and A. R. Zota sit on BCPP advisory committees.

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We Need Environmental Health Justice Research and Action for LGBTQ+ People

Timothy W. Collins, PhD, Sara E. Grineski, PhD, and Danielle X. Morales, PhD

ABOUT THE AUTHORS

Timothy W. Collins and Sara E. Grineski are with the Center for Natural and Technological Hazards, University of Utah, Salt Lake City. Timothy W. Collins is also with the Department of Geography, University of Utah. Sara E. Grineski is also with the Department of Sociology, University of Utah. Danielle X. Morales is with the Department of Sociology and Anthropology, University of Texas at El Paso.

See also Levy and Hernández, p. 48, and Goldsmith and Bell, p. 79.

Goldsmith and Bell (p. 79) coalesce findings from the few studies that have examined and documented patterns of environmental injustice for lesbian, gay, bisexual, transgender, queer or questioning, and other (LGBTQ+) populations into a novel, preliminary framework that should guide future research. We know very little about environmental health injustices experienced by LGBTQ+ people despite evidence that many of the conditions disproportionately affecting this community have definitive environmental etiology (e.g., cancers, respiratory diseases) or are influenced by or interact with environmental exposures (e.g., obesity, stress, depression, suicidality, HIV).

We know that oppressive social institutions and structures constrain residential choices, employment opportunities, and health care access; generate social stress; and influence risky health behaviors (e.g., smoking) among LGBTQ+ people; therefore, we should expect this community to experience environmental injustices and compounding health effects. We base that expectation on the analogous marginalization of people of color in the United States and their well-documented experiences of environmental injustice.[1] With that understanding, we conducted initial LGBTQ+ environmental justice research several years ago. We found that neighborhoods with high compositions of same-sex partner households experienced disparate residential exposures to air pollution in Greater Houston, Texas,[2] and nationwide.[3] Unfortunately, few scholars have sought to expand knowledge of LGBTQ+ environmental health justice in the intervening years. Thus, Goldsmith and Bell's article comes as a welcome, albeit overdue, contribution.

OVERLOOKING ENVIRONMENTAL HEALTH JUSTICE

Fields of research on environmental justice and LGBTQ+ health disparities have emerged over roughly the same period—from 1980 to the present—yet they have evolved as separate domains (with the exception of the few studies that Goldsmith and Bell review). Competing claims about the existence of racially unequal exposures drove the development of the environmental justice field, and many environmental justice analysts tested the question of whether race (especially Black vs White) or class more powerfully explained variation in environmental exposures.[4] Because of the political contestation underpinning environmental justice research, the unjust environmental exposures experienced by some people of color, such as Asian Americans, went largely overlooked until recently.[5,6] Over the past two decades, environmental justice research has expanded to evaluate disparate environmental exposures based on other axes of social oppression (e.g., gender, age, religion, and immigration status), yet the environmental justice field has neglected to examine environmental injustices experienced by LGBTQ+ people.

Scholars of LGBTQ+ health disparities have ignored the role of the physical environment, largely because of their field's disciplinary–theoretic orientation. In a 2016 *AJPH* editorial, Stall et al. traced the development of research on LGBTQ+ health disparities.[7] Studies have expanded from small-scale analyses of psychosocial health problems and AIDS based on convenience samples to large-scale epidemiological studies of representative cohorts in which rigorous comparisons with the cisgender, heterosexual population have documented disparities for LGBTQ+ populations. Still, theoretical frameworks orienting the field prioritize psychosocial pathways translating stressful life experiences of antigay stigmatization and victimization into disproportionate health risks. Extending from such frameworks, recent research has documented syndemics of traumatic experiences, psychosocial health problems, and behaviorally mediated physical health conditions in LGBTQ+ populations. And although the contextual roles of policy structures, social environments, and intersectional oppression in LGBTQ+ health problems have received recent analytical attention, environmental injustice has not, in part because we have failed to recognize the LGBTQ+ population as an environmental justice community in research and practice.

Recent advances in knowledge are partly attributable to US science institutions taking seriously the need to expand the LGBTQ+ health research enterprise. In 2011, the National Academy of Medicine released a report outlining research status, challenges, and needs.[8] This was followed in 2013 with an official statement elevating the importance of research on LGBTQ+ populations[9] and the 2015 establishment of the Sexual & Gender Minority Research Office by the National Institutes of Health (NIH). Subsequent NIH funding reflects prioritization of research on LGBTQ+ health disparities. Our NIH RePORTER (Research Portfolio Online Reporting Tools Expenditures and Results) database search revealed the expansion of annual funding for research on LGBTQ+ populations from hundreds of thousands of dollars in the early 2000s to hundreds of millions by 2019. Our search also revealed no NIH-funded projects focused on environmental exposures in LGBTQ+ populations. We cannot ascertain whether scholars have not proposed such research or whether the disciplinary–theoretic organization of this field has rendered such proposals uncompetitive.

Whatever the case may be, the two most relevant research fields and federal funding initiatives have overlooked a topic of import. That needs to change if we are to develop a genuinely integrated understanding of LGBTQ+ health disparities.

ADVANCING KNOWLEDGE

We need more research on LGBTQ+ environmental health justice, which demands coordinated efforts. Federal funding agencies and private foundations should recognize that environmental exposures play a role in LGBTQ+ health and support research on this topic. LGBTQ+ environmental health justice research has the potential to characterize causal processes that underlie specific health disparities in subpopulations as well as health disparities that remain undetected. Scholars must span the boundary separating the environmental justice and LGBTQ+ health disparities fields through collaborative projects, because expertise from both is foundational.

Advancing knowledge also depends on improving data on LGBTQ+ populations, which Goldsmith and Bell detail. For example, our own studies used aggregated Decennial Census data on same-sex partner households, which comprise a fraction of the LGBTQ+ population, and we could only differentiate households based on binary biological sex categories.[2,3] Developing an intersectional understanding of LGBTQ+ environmental health injustice requires analyses of large, representative, individual- and household-level data sets with information on sexual orientation, gender identity, race/ethnicity, socioeconomic status, age, immigration status, health care, health status and behaviors, lifetime trauma, social support, and geographic identifiers of homes and workplaces. Better data will enable the examination of direct, indirect, and interactive effects of environmental exposures, intersecting identities, and structural factors on health disparities experienced by subgroups in the LGBTQ+ population.

PROMOTING ENVIRONMENTAL HEALTH JUSTICE

We must build more knowledge of LGBTQ+ environmental health injustice before we can target appropriate and effective public health interventions. What can we do in the meantime? A key implication of Goldsmith and Bell's article, along with the handful of previous studies that orient it, is that LGBTQ+ populations experience environmental injustices that have gone unrecognized by scholars of environmental justice and LGBTQ+ health, policymakers, activists, public health workers, and the public. Promoting LGBTQ+ environmental health justice involves identifying and ameliorating distributional and procedural injustices, but more fundamentally it depends on recognizing these people's manifold experiences of social and environmental oppression.[10]

We should take the recent federal shift as an opportunity to include LGBTQ+ voices in important discussions about environmental justice. The federal government should promote LGBTQ+ recognition justice by revising Executive Order 12898—Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (1994)—which mandates that agencies make achieving environmental justice part of their missions by identifying and addressing disproportionate effects of their activities. Revising Executive Order 12898 to mandate the consideration of disparate environmental impacts on LGBTQ+ populations is critical. The renewed federal emphasis on environmental justice, including the establishment of the White House Environmental Justice Advisory Council, indicates that we are in a moment of possibility. However, the council's recently released final recommendations for revisions to Executive Order 12898 fail to recognize the LGBTQ+ population as an environmental justice community.[11] Before we can take meaningful action, we must recognize LGBTQ+ people's experiences of environmental injustice. We hope that Goldsmith and Bell's article and our own work[2,3] help enhance broader societal recognition. AJPH

CORRESPONDENCE

Correspondence should be sent to Timothy W. Collins, University of Utah, Department of Geography, 260 Central Campus Dr., Rm. 4728, Salt Lake City, UT 84112 (e-mail: tim.collins@geog.utah.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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Queering Environmental Justice Through an Intersectional Lens

Greta Gaard, PhD

ABOUT THE AUTHOR

Greta Gaard is with the English and Women/Gender/Sexuality Studies Departments, University of Wisconsin, River Falls.

See also Levy and Hernández, p. 48, and Goldsmith and Bell, p. 79.

Bell and Goldsmith's research (p. 79) establishes a new intersectional field of queer environmental justice through the feminist practice of "asking different questions" and investigating queer populations and their health outcomes as exacerbated by environmental exposures, along with "social institutions and entrenched discrimination that affect many aspects of LGBTQ+ [lesbian, gay, bisexual, transgender, queer or questioning, and other] lives, such as education, health care, and access to resources during an environmental disaster" (p. 86). They define environmental exposures in terms of "where LGBTQ+ people live," a decision influenced not only by race, class, income, and availability of federal loan programs, but also by local, regional, state, and national contexts of institutionalized and interpersonal homophobia and discrimination.

During the period of data collection for their article, domestic partnership registries seemed to be the primary data source for determining residence locations for same-sex and queer domestic partners. Future research building on this article can be updated to show the influence of the Supreme Court's decision to legalize same-sex marriage[1] and the potential shifts in residence for same-sex spouses and their families. This legal protection may promote greater accessibility to healthy housing environments, a view that the 2020 Census data—for the first time in US history—can be used to assess.

Queering environmental justice can be further developed through the intersectional feminist lenses of gender, age, ability, and species.[2]

Bell and Goldsmith identify intersections between physical and mental health, noting the ways that "institutional and social-based discrimination and stigma" manifest psychologically, prompting LGBTQI (lesbian, gay, bisexual, transgender, queer or questioning, and intersex) persons to conceal identity, internalize oppression, and live in fear of identity-based rejection, with transgender persons facing even more mental health burdens (40%) than cisgendered LGB persons. At the same time, even cisgendered lesbian and bisexual queer women experience the intersections of environmental sexism and ageism in addition to environmental homophobia, producing intensified relations of dominance enforced via sexual assault, harassment, bullying, exploitation, and hate crimes.[3] Bringing forward intersections with age, gender, and sexuality makes visible the high percentage of sex work performed by outcast and runaway queer, trans, and cisgendered youth.[4] Because of the nexus of sexism, heterosexism, ageism, and racism, the environments of queer and trans sex workers are inherently unjust and unhealthy—both physically and mentally—carrying increased risks of HIV transmission, alcoholism, drug use, and environmental toxins.[5]

Intersections of gender, sexuality, and environments also play a role in queer women's higher rates of obesity[6] and their tendencies to avoid breast and pelvic exams[7] at rates comparable to those of transmen, who also tend to avoid screenings for cervical cancers.[8] Both physical and sexual health exams carry the risk of homophobic and transphobic harassment or ignorance in medical work environments. It remains a well-known tragedy that transgender author, labor activist, and human rights activist Leslie Feinberg died in 2014 from the untreated outcomes of Lyme disease and other tick-borne infections.

Queer disability author Piepzna-Samarasinha[9] argues that genuine social and environmental justice must include age and disability justice. Environmental disasters such as Hurricane Katrina support this claim; although age and disability often co-occur, impairments of hearing, vision, cognition, speech, and mobility can affect people of all ages, making it difficult for them to seek protection in climate crises. For elderly people, these impairments are more likely and more challenging, and for queer and disabled people, seeking appropriate aid in environmental disasters can be triply challenging. Young people are at greater risk; given the disproportionate racial impact of asthma among urban and lower-income children of color, the ability of children to breathe while fleeing

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or surviving climate disasters is an environmental justice issue, compounded by homophobia if their parents, siblings, or extended family are queer or trans.

In addition, the intersections of environmental justice, queer justice, and species justice are entangled in the lives of multispecies families. Speciesism obscures the ways that human lives are lived in relationship with other species as well as environments; nearly half of those who stayed behind during Katrina refused rescue helicopters and boats that offered safety only to humans, and stayed because of their companion animals. During the COVID-19 pandemic, queer families maintained well-being and mental health through adoption and relationships with companion animals.[10] For older LGBTQ+ adults, both single and partnered, companion animals are "lifesaving in every way," from greater mental and physical health to enriched social networks.[11] In sum, leading environmental justice scholars have recognized that their analytical frameworks will miss important data unless they include multispecies lives.[12] AJPH

CORRESPONDENCE

Correspondence should be sent to Greta Gaard, Department of English, 256 KFA, University of Wisconsin-River Falls, 410 S. Third St, River Falls, WI 54022 (e-mail: greta.gaard@uwrf.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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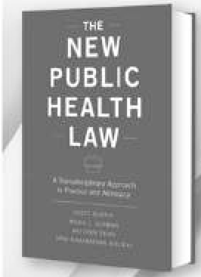

Heading Upstream: Strategies to Shift Environmental Justice Research From Disparities to Equity

Daniel Carrión, PhD, MPH, Annie Belcourt, PhD, and Christina H. Fuller, ScD, MS

ABOUT THE AUTHORS

At the time of writing, Daniel Carrión was with the Department of Environmental Medicine & Public Health, Icahn School of Medicine at Mount Sinai, New York, NY. Annie Belcourt is with the Department of Public and Community Health Sciences, College of Health, University of Montana, Missoula. Christina H. Fuller is with the Department of Population Health Sciences, School of Public Health, Georgia State University, Atlanta.

See also Levy and Hernández, p. 48.

Environmental racism is historically rooted in planned resource inequalities and restricted access to nature for Black, indigenous, and people of color (BIPOC). Present-day and historical manifestations of systems of oppression inform each aspect of environmental inequalities. This constellation of factors determines who is exposed to environmental harms, who has the resources to adapt to harms, who develops conditions making them more susceptible to harm, and, ultimately, who lives and dies.

Policies have historically prioritized White communities via opportunities to accumulate wealth through segregation, gentrification, and systematic preclusion of BIPOC communities from economic and educational opportunities.[1–4] According to a Brazilian proverb, "The hearts of the poor do not beat, they are beaten." Infrastructural investments have not been equally distributed, as evidenced by the Interstate Highway System, which destroyed vibrant Black communities.[5] Indigenous communities were forced from ancestral lands to locations lacking sustainable resources and breaking connections with traditional ecological knowledge and belief systems tied to place and nature. Hispanic and Latinx people have historically lived near major roadways, breathe some of the most polluted air in the nation, and often experience higher exposures to pesticides.[6]

Environmental justice (EJ) actions emanate from places such as Warren County, North Carolina; the Black Hills and Paha Sapa of South Dakota; Los Alamos, New Mexico; and Mauna Kea in Hawaii, which have all been marked by injustice. These actions were taken to resist hazardous waste landfills being built in poor, majority Black communities; oil pipelines, telescopes, and monuments carved into sacred landscapes; Mexican and Central American farmworkers being exposed to pesticides; and mining and petrochemical industries disproportionately affecting Puerto Ricans.

EJ is a grassroots struggle, yet too frequently BIPOC are excluded from or marginalized in mainstream environmental organizations and research. Lessons learned from the struggles for justice have led to increasing recognition that intersectional and multiscalar approaches to EJ are necessary.[7,8] As researchers in this field, we aim to identify existing and emerging trends in how scientists and communities recognize, frame, and conduct EJ research. Our goal is to create more accurately informed science and practice aimed at creating inclusive, responsive, and respectful research resulting in environmental health equity.

INCLUSIVE ENVIRONMENTAL JUSTICE RESEARCH

Multiple pressing environmental issues have profound justice implications, from persistent and disproportionate exposures to air pollution, metals, noise, and product-based chemicals and inequitable access to green spaces to uneven risks of exposure to extreme heat and flooding and worsening allergens from climate change. Rather than listing and dissecting these concerns, we propose an action-oriented framework for researchers, practitioners, and communities alike. This framework requires us to "remember" past injustices," "reflect" on present-day implications, "restore" and "reclaim" traditional knowledge and ecological health, and "reinvest" in BIPOC communities.

Remember and Reflect

Environmental health disparities are not natural, fixed, or innate but have historical roots in interlocking systems of oppression that created, and now perpetuate, those disparities. EJ literature has documented disparities in environmental exposures by race, ethnicity, and poverty, and a growing body of literature relates mechanisms of oppression to disparities and differences in environmental exposures.[9] A first step for EJ research is to remember the historical events and processes that led to the differences we observe. This means we must move beyond simple documentation of exposure disparities by group identity to determine the mechanisms that produced those differences. For example, it is not that Black communities are inherently at risk for extreme heat or flooding events; rather, historical and ongoing residential segregation has led to planned differences in neighborhood land cover that are associated with extreme temperatures and flooding.[10,11]

Furthermore, mechanisms that created exposure disparities may or may not be the same as those that currently perpetuate those disparities. Consequently, we must reflect on present-day structures to identify targets for intervention and design research and policy agendas accordingly. Embracing the complexity of intersectionality is necessary to identify and characterize the upstream determinants of environmental disparities. There is potential for this approach in studying risks associated with beauty product use among Black women and uterine fibroid disparities.[7] These frameworks are important to understand patterns of disparities between exposures and outcomes.

Restore and Reclaim

Another important direction for EJ research and policy-making pertains to the ability to reclaim and restore ecological health and physical environments. For example, many BIPOC communities have deep connections to green spaces, historical lands, and foods that serve as sources of resilience.

In the case of foods, indigenous scholars and activists have begun a journey toward food sovereignty, including reclamation of native diets that were suppressed through colonization. This includes cultivation of traditional foods and banking of seeds from those crops. Supporting agricultural diversity has important benefits for climate adaptation, as monoculture farming is increasingly vulnerable to changing conditions. As for green spaces, increasing evidence supports their health benefits, but BIPOC communities have been historically excluded from those spaces. When they do exist, they are often unusable or poorly maintained, as in the case of abandoned lots. Transformation of those lots into usable space can have positive health effects.[12] Although improved access to healthier foods and to green spaces are tangible examples, researchers must listen to communities to identify opportunities for restoration and reclamation interventions that support environmental and health equity.

Reinvest

Many BIPOC communities have experienced decades of disinvestment, resulting in dilapidated housing, poor infrastructure, and lack of amenities. These conditions may lead to poor drinking water quality, wastewater conveyance and treatment, and heating and cooling efficiency. Investments in BIPOC communities are vital to improve material conditions and thus interrupt exposure pathways. Researchers should collaborate with community partners to identify areas of reinvestment, conduct research that quantifies potential gains in investments, and support dissemination of the findings of such research. For example, health impact assessments can be leveraged to quantify the possible health benefits of policy and investment scenarios proposed by community leaders. Results can provide the evidence base on which policymakers allot reinvestment dollars.

Furthermore, as a result of residential segregation in the United States, co-location of deleterious environmental and social determinants of health is common.[13] Interventions maximizing benefits across environmental and social determinants of health should be prioritized. Such research agendas require collaboration between diverse stakeholders and interdisciplinary experts to identify, model, and articulate these interventions.

One downstream challenge posed by investments that improve the environmental quality of BIPOC communities is the concern regarding gentrification, sometimes referred to as “green” or “environmental” gentrification. It is counterproductive to target place-based environmental interventions within BIPOC communities if such interventions result in the ultimate displacement of those communities. There is growing concern over climate gentrification in communities that have historically low property values but land that is now deemed “desirable” on the basis of climate projections (e.g., higher elevation in a coastal city).[14] Therefore, researchers should include both places and people in conducting assessments and devise interventions or mitigation plans that avoid displacement, such as affordable housing and land grants.

CONTINUUM OF COMMUNITY-ENGAGED RESEARCH

The framework we have conceptualized speaks to potential content areas of EJ research but does not address methods or approaches. Achieving environmental health equity requires us to put the 17 principles of environmental justice into action. One of these principles is the inclusion of communities in decision making, assessment, planning, implementation, enforcement, and evaluation. During our careers, we have noted that many researchers are not trained in community-engaged research and may oversell community involvement in studies, which can lead to deterioration of community relationships. Authentic community-engaged research is pivotal in local EJ efforts for multiple reasons.

For example, most researchers are not from the region or community in which they work and thus have limited familiarity with local issues, histories, and power dynamics. Also, research results can have more profound effects because community partners are more likely to disseminate and direct findings to decision makers such as legislators and local leaders. Other benefits include the availability of relevant health questions, improved recruitment and retention, and potentially more accurate data.

Community-engaged research is not a single formula but instead a continuum of activities and relationships that foster collaboration and resource sharing.[15] On one end of the spectrum is outreach, which includes the least amount of community involvement, and on the other end is community-based participatory research and community-led research. Community-based participatory research is a framework whereby communities and researchers jointly contribute to each stage of a study and power and resources are shared equitably among partners. However, this framework requires substantial financial and time investments (typically unfunded) to build and sustain collaborations. Many community groups lack access to the scientific and professional infrastructure (e.g., publications and costly equipment) to conduct and disseminate research, which increases the need for investments in building scientific capacity. Researchers will likely move along the community-engaged research continuum with various studies, but we encourage genuine, transparent, and honest relationships.

CONCLUSIONS

Creating equity in environmental public health requires active steps toward both understanding and dismantling sources of inequity and oppression experienced by BIPOC communities. Inclusion of diverse voices, wisdom, and knowledge will help to promote better science and healthier communities. AJPH

CORRESPONDENCE

Correspondence should be sent to Christina H. Fuller, ScD, MS, Urban Life Building, 140 Decatur St, Suite 449, Atlanta, GA 30303 (e-mail: cfuller@gsu.edu). Reprints can be ordered at http://www.ajph.org by clicking the “Reprints” link.

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Frontline Organizations Play a Vital Role in Movement Ecosystems; Let's Fund Them to Thrive

Dana L. Bourland, AICP, Lois DeBacker, Ogonnaya Dotson Newman, and Anna Loizeaux

ABOUT THE AUTHORS

Dana L. Bourland, Ogonnaya Dotson Newman, and Anna Loizeaux are with The JPB Foundation, New York, NY. Lois DeBacker is with The Kresge Foundation, Detroit, MI.

See also Levy and Hernández, p. 48.

As the COVID-19 pandemic gathered deadly force in the spring of 2020, frontline organizations stepped up, organizing mutual aid hubs, distributing food and personal protective equipment, and checking on elders. These organizations—which work on environmental, climate, and other social justice issues—are well-positioned to support the needs of their communities. Led mostly by low-income people and people of color, and accountable to those they serve, frontline organizations are trusted messengers and leaders.

That leadership has proven essential in the pandemic and in other crises. For example, in Skagit County, Washington, *promotoras* from Community to Community worked to counter misinformation about COVID-19 among farmworkers. In San Antonio, Texas, the Society of Native Nations brought sanitation supplies to elders and the homeless. And in New Orleans, Louisiana, Healthy Community Services and other grassroots organizations are installing green infrastructure to mitigate flooding in low-lying neighborhoods.

In effect, frontline organizations are serving as first responders—meeting their neighbors' immediate needs while working to prevent the next crisis by tackling systemic problems. They have an impressive track record of success at the local level and beyond.

Yet, frontline organizations are routinely overlooked by funders. A report by Building Equity and Alignment for Environmental Justice found that, in some regions, only about 1% of grants from the 12 largest environmental funders went to grassroots environmental justice organizations.[1] And, while climate change disproportionately affects communities of color (https://www.epa.gov/cira/social-vulnerability-report), The Solutions Project reports that half of philanthropic funding on climate issues goes to 20 national organizations, which are mostly led by White men (https://thesolutionsproject.org).

This is a system that is profoundly out of balance. As environmental grantmakers, we think of the movements we fund as an ecosystem. In a healthy ecosystem, a diverse array of actors function at various scales, forming an interdependent whole. While these movements are certainly diverse, their funding streams are more of a monoculture—supporting one type of organization while neglecting others, and weakening the system overall.

This needs to change. To meet the crises and opportunities of the 21st century, we must support thriving movement ecosystems that prioritize frontline organizations working at the intersection of environmental, climate, and social justice. Our foundations, and many others, have made a commitment to provide that support. Now we must put our commitments into action.

THE PROBLEMS—AND SOLUTIONS—ARE CONNECTED

The movement ecosystem approach is not new. Thirty years ago, delegates to the First National People of Color Environmental Leadership Summit drafted 17 Principles of Environmental Justice. The principles affirm the sacredness of Mother Earth, the interdependence of all species, and the right to self-determination, among other core values. Five years after the Summit, a diverse group of activists developed the Jemez Principles for democratic organizing, which call for inclusivity, just relationships, bottom-up organizing, and more. Together, these two documents illuminate the values of frontline environmental justice organizations.

Frontline organizations understand that the great problems of our time—racial injustice, economic inequity, environmental injustice, and gendered violence—are inextricably entwined. Consider the fact that Indigenous persons and people of color are more than twice as likely to die of COVID-19 as their White counterparts.[2] This disparity is rooted in racist policy and practice, including unequal access to health care and secure housing, and exposure to particulate matter from the concentration of polluting industries in communities of color.[3] An effective public health response demands attention to these inequities and other social and environmental determinants of health.[4]

The same is true for climate change. While a growing number of people are affected by the destabilized climate, people of color and low-income communities still bear the greatest burden (https://www.epa.gov/cira/social-vulnerability-report). This means more suffering in communities that have long served as sacrifice zones—hosting the fossil-fuel infrastructure that would never be built in affluent White neighborhoods.[5]

AN EFFECTIVE APPROACH

For decades, frontline organizations have taken a holistic approach to these interconnected problems. It is an approach that is achieving simultaneous gains for people and the planet, at the local, state, and national levels.

In Los Angeles, California, Communities for a Better Environment and Esperanza Community Housing—longstanding environmental and housing justice advocates—along with Physicians for Social Responsibility-LA, successfully pushed the city to establish a Climate Emergency Mobilization Office. Now, these organizations are working to ensure that grassroots communities of color are at the forefront of climate disaster planning.

At the state level, New York Renews—a coalition of more than 200 organizations—was instrumental in the passing of New York State's 2019 Climate Leadership and Community Protection Act. The act calls for 70% renewable energy statewide by 2030, and full carbon neutrality by 2040. Frontline organizations made sure the act addresses historic inequities, by ensuring that climate programs benefit disadvantaged communities.[6]

And frontline organizations are shaping national policy. The New York climate act served as a model for President Biden's landmark Justice40 Initiative, which will direct 40% of infrastructure and clean energy investments to communities burdened with environmental injustice. A coalition of grassroots and national environmental groups coauthored the Equitable and Just National Climate Platform, a plan to tackle the climate crisis while advancing economic, racial, and environmental justice. The Platform's authors are advising the Biden administration on the implementation of Justice40.

SHIFTING SUPPORT

Today, resources are beginning to shift, as foundations (including ours) direct more funding to frontline organizations. Earlier this year, the Donors of Color Network issued a challenge to climate funders, asking us to direct at least 30% of our grantmaking to organizations that are led by people of color and accountable to their communities while providing greater transparency in grant reporting (https://climate.donorsofcolor.org). A total of 16 climate funders have met the target or pledged to do so. Recently, the Bezos Earth Fund, which has drawn criticism for favoring national groups with multimillion-dollar reserves, announced significant new funding that includes support for environmental justice work. It is a step forward, but far less than what is needed.

There is much more we can do. Funders can support the full ecosystem of care and change: frontline organizations, national organizations, and movement networks. Multiyear general support grants can give grassroots groups the flexibility they need to raise funds and respond to emergent crises—as they have during the pandemic. Video application processes can make it easier for frontline groups to apply for grants. Review panels can be expanded to include activists with firsthand experience in grassroots work. And funders can leverage the power of intermediaries in service of and accountable to grassroots communities to complement direct grants to community-based organizations.

Importantly, we can ask whether our institutions live up to their professed principles and values—in our grantmaking, our investments, our hiring, and our way of being in relationship with each other.

The pandemic has illuminated our interdependence as never before. It has made visible the threads that connect our own health and well-being to that of others, known and unknown. And it has vividly shown our dependence on the first responders and other essential workers on the front lines of this—and every—crisis. It has underscored the critical, and fraying, ecosystem of care on which our lives depend.

The movement to protect our shared environment is also an ecosystem, and it is dangerously out of balance. For that movement to thrive, we must nourish those with deep roots in the soil of community—and strengthen the ties among all of the system's diverse inhabitants. Frontline organizations are first responders, caring for their communities, and agents of lasting change. While philanthropy and government are beginning to understand the importance of this essential work, greater recognition—and more funding—must follow. AJPH

CORRESPONDENCE

Correspondence should be sent to Ogonnaya Dotson Newman, 875 Third Ave, 29th Floor, New York, NY 10022 (e-mail: onewman@jpbfoundation.org). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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Climate Justice Starts at Home: Building Resilient Housing to Reduce Disparate Impacts From Climate Change in Residential Settings

Diana Hernández, PhD

ABOUT THE AUTHOR

Diana Hernández is with the Mailman School of Public Health at Columbia University, New York, NY.

See also Levy and Hernández, p. 48.

Housing is a quintessential element in the race against climate change. The home environment is also where climate impacts are intimately experienced. People are increasingly reliant on residential settings to keep them safe from more frequent and intense extreme weather events such as storms, heat waves, flooding, and droughts.[1] These conditions not only overload home-based infrastructure but they also strain inhabitants socially and economically. From a justice perspective, communities of color, low-income groups, the elderly, and the medically vulnerable are disproportionately affected by housing-related climate impacts and face significant barriers to prevent, respond to, or mitigate adverse outcomes.

The residential sector has long been implicated in contributing to harmful greenhouse gas (GHG) emissions, which are the main culprits of climate change. A recent study estimated that residential energy use accounts for 20% of all GHG emissions in the United States.[2] The authors warn that continued reliance on fossil fuels in newer homes and delays in decarbonizing the residential sector will hamper efforts to eliminate housing-related GHG emissions.[2] While this comprehensive analysis answers a critical question about the extent to which housing contributes to climate change via GHGs, the existing literature generally ignores the other ways in which housing and climate change are interlaced.

This editorial centers housing as the venue in which less predictable and more intense climate conditions are experienced while pointing to the inherent inequalities therein. It uses a housing and environmental justice lens to understand disparities in climate change impacts while proposing a resilient housing framework to be integrated in climate action plans and just transition policies.

HOUSING AND CLIMATE CHANGE

Swope and Hernández identified the four pillars of housing as cost, conditions, consistency, and context, referring to housing affordability, indoor environmental quality, residential stability, and neighborhood risks and assets, respectively.[3] Climate change is effectively compromising the capacity and stability of each of these pillars in unique ways:

1. The cost of housing in flood-prone areas has increased because of higher insurance rates; meanwhile, housing operating costs have swelled with more maintenance and repair needs in the aftermath of extreme weather.
2. The conditions of housing are also more precarious as a result of moisture and mold stemming from flooding, storm-related power outages, and greater air conditioning demands from heat waves.
3. The ability to remain in one's home or ensure its structural integrity is jeopardized by drought-induced wildfires, hurricanes, and storms that have caused billions of dollars in property damage and forced families to temporarily relocate or be permanently displaced.
4. Given the patterning of homes and the often uneven allocation of resources, those most affected by these extreme weather events are also often the least able to rebound, not just on an individual household level but also at the community scale.

Using the four pillars of housing framework, below I describe in greater detail the ways in which housing and vulnerable inhabitants face unprecedented risk in the context of climate change.

Costs

Over the past two decades, the price of housing in the United States has increased exponentially for renters and owners across the United States, with low-income households more likely to shoulder the greatest cost burdens.[4] Homes are not only more expensive to live in but they also vary drastically by energy performance.

Ironically, higher-income households pay less for utilities despite consuming more energy per capita and square foot because they enjoy greater energy efficiency, which drives down costs and delivers enhanced comfort. On the other hand, low-income households often go to extreme measures to conserve energy yet experience higher energy use intensity because of housing conditions that cause heating and cooling losses or because of barriers to upgrading to more efficient energy infrastructure including appliances and heating and cooling systems.[5] Black households, including those with higher incomes, are also more likely to live in less-efficient homes, demonstrating the legacy problems of housing segregation, redlining, and lack of equitable access to financing. These additional energy costs affect housing costs overall and, in turn, influence energy, housing, and dual economic burdens.[6,7] Moreover, Black and low-income households are at acute risk of being underinsured or completely lacking homeowners' or renters' insurance because of high costs.[8] These groups are thus more vulnerable to significant losses and protracted recovery from disasters.

Conditions

Climate change is straining housing infrastructure because of excess heat and cold, storm-related power and telecommunications outages, and added moisture from flooding following heavy precipitation. Rising temperatures have contributed to record heat and extreme weather across the globe. On the housing front, this means that heating and cooling demands are higher, which adds pressure to the existing energy infrastructure for thermal conditioning.[9] Some homes lack the necessary equipment, while vulnerable householders may deny themselves comfort to reduce utility costs. This trade-off can increase the risk of heat- and cold-stress–related illness and induce other forms of hardship such as food insecurity as people decide between heating and eating. Extreme temperatures can also be deadly.[10]

Furthermore, power, water, and telecommunications outages are more commonplace as a result of extreme weather. Living without electricity, clean water, or access to Internet and cell phones can complicate daily life and compromise health, especially for the medically vulnerable. Excess dampness and moisture in homes is known to instigate the presence of mold. Mold is a known concomitant of respiratory conditions such as asthma and acute respiratory illness in adults and children. With greater precipitation and flooding from storms, there are more opportunities for mold to fester.[11]

Consistency

The immediacy of climate-related threats often translates into the need to evacuate homes and leave personal belongings behind to seek personal safety. Drought-induced wildfires, hurricanes, tornadoes, and other storms have claimed homes, leveling structures and the memories, hopes, investments, and residential stability contained therein. While at times the displacement is temporary, such that affected householders return to their homes to repair and clean out damage, in some instances the dislocation is permanent. The emotional toll and economic devastation can represent long-term setbacks; these trajectories are not evenly distributed. For example, during Hurricane Katrina, more than a million Gulf Coast residents were displaced. Almost a quarter of New Orleans, Louisiana, residents never returned. Many of the involuntarily dispossessed, most of whom were Black and low-income, experienced worse health, economic, and housing outcomes following the storm.[12]

Context

Neighborhood factors such as school quality, access to green space, crime rates, and the absence of environmental hazards have traditionally affected property values. Increasingly, the imperative to live in climate-safe regions with protective features, such as higher elevation, have affected housing markets. The ensuing "climate gentrification" has driven disadvantaged residents out of desirable communities and into riskier environments.[13] Existing evidence shows a clear pattern of climate gentrification in several US cities following storms (e.g., post-Katrina New Orleans) and in areas facing flood risks (e.g., Miami, Florida). These factors have compounded the economic tensions already at play in lower-income, racially minoritized, and immigrant communities that have forced longtime residents out of gentrifying or gentrified communities, thereby presenting new pressure points in the context of climate change.[14]

RESILIENT HOUSING IN THE FACE OF CLIMATE CHANGE

Expectations that disproportionately affected populations be more resilient in the face of climate change are misguided.[15] Instead, we should focus on fostering resilient physical and social structures to ensure that those facing disproportionate risks can better prepare, prevent, respond to, and recover from extreme weather and disasters. As both a material good and social institution, housing represents an important focal point for advancing climate justice. Informed by the four pillars of housing framework,[3] "resilient housing" entails (1) a reinforced physical infrastructure, (2) economic supports, and (3) social connectedness with a particular emphasis on protecting low-income persons, aged individuals, and communities of color from climate harms:

1. Homes should be better equipped with clean and efficient energy technologies, weatherization, and floodproofing measures to decrease operating costs, improve thermal control, reduce excess GHGs, and shield against property damage.
2. Energy assistance benefits and home insurance coverage need to be more robust, easier to acquire, and fairly distributed to ensure that people have the means to maintain comfort, reduce financial trade-offs, and rebuild after storms.
3. Protections against climate gentrification and long-term displacement will help ensure that community members can count on neighbors that they know and trust and shield against the formation of "climate ghettos," where those with the lowest means will face the greatest environmental threats. Moreover, coming back home and remaining rooted in one's community should not be a matter of privilege but a choice that is protected.

CONCLUSION

Homes act as a crucial vector through which climate change is proximally experienced. People's residences provide shelter and protection from the elements and enable social connectedness. People of color, low-income persons, the elderly, and the medically vulnerable not only face disproportionate climate risks but they also face various forms of housing insecurity. Resilient housing can uphold the principles of climate justice by ensuring that all populations have a structurally and socially sound platform by which to withstand the impacts of climate change. AJPH

CORRESPONDENCE

Correspondence should be sent to Diana Hernández, 722 W 168th St, 9th Floor, New York, NY 10032 (e-mail: dh2494@cumc.columbia.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONFLICTS OF INTEREST

There are no conflicts of interest to report.

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Addressing Gaps in Public Health Education to Advance Environmental Justice: Time for Action

Carly R. Levy, DHS, MPH, CPH, Lynelle M. Phillips, RN, MPH, Carolyn J. Murray, MD, MPH, Lindsay A. Tallon, PhD, MSPH, CPH, and Rosemary M. Caron, PhD, MPH

ABOUT THE AUTHORS

Carly R. Levy and Lindsay A. Tallon are with the Master of Public Health Program, School of Arts and Sciences, Massachusetts College of Pharmacy and Health Sciences, Boston. Lynelle M. Phillips is with the Department of Public Health, School of Health Professions, University of Missouri, Columbia. Carolyn J. Murray is with the Master of Public Health Program, Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine at Dartmouth, Hanover, NH. Rosemary M. Caron is with the Department of Health Management and Policy, Master of Public Health Program, College of Health and Human Services, University of New Hampshire, Durham.

See also Levy and Hernández, p. 48.

At a time when environmental public health crises dominate headlines, ranging from the COVID-19 pandemic originating from a zoonotic source to extreme weather events linked to global climate change, we want to call attention to the erosion of environmental health (EH) content within master of public health (MPH) programs. The lack of EH content in MPH programs places the already strained public health workforce at risk for not adequately understanding the close interdependence of health on the environment and the major public health challenges of our time, from climate change to systemic racism.

A major contributing factor to the decline in EH curricula may be the revision of the Council on Education for Public Health (CEPH) accreditation standards for schools and programs in public health in 2016, which was done with the intention that graduates from all MPH programs would demonstrate foundational public health knowledge and competencies.[1] Yet five years later, the curricular revisions and course restructuring initiated by public health schools and programs in response to the revised CEPH requirements have resulted in a reduction of EH courses offered.[2]

Other contributing factors to the decline in EH content could be at play, including not understanding the foundational role of the environment in health and years of inaction on climate change, leading to a consequential lack of demand from students. However, interests of incoming students appear to be shifting as they are in other health professions seeking to add EH content to prepare their future workforce to be skilled in managing complex, interdisciplinary public health challenges of environmental origin.[3,4]

The Association for Prevention Teaching and Research, via a working group on EH competency, reviewed these trends in public health education and expressed concern over this disconnect in the public health learning curriculum. Here we describe more fully the unintended consequences for graduate public health education of the CEPH accreditation revisions related to EH, the potential consequences for the public health workforce, and recommendations for reversing these effects and fostering innovative EH education for the next generation of public health professionals.

PROBLEM STATEMENT

CEPH serves as the US Department of Education’s approved accrediting body for schools and programs of public health.[5] Previous CEPH accreditation criteria in 2011 required graduate public health education in five core areas (biostatistics, epidemiology, environmental health sciences, health services administration, and social and behavioral sciences).[6] CEPH subsequently engaged in a multistakeholder accreditation review process focused on aligning academic training with public health workforce needs.[7] This comprehensive process resulted in the current 2016 competency-based accreditation model, which requires foundational knowledge and competencies for undergraduate and graduate public health curricula.[7]

Specific to master’s-level public health education, there are 12 learning objectives covering foundational public health knowledge and 22 foundational competencies.[1] Explaining the role of environmental factors in a population’s health is required as a CEPH learning objective only. Learning objectives are less advanced than the CEPH-defined competencies designed as outcomes of graduate public health education.[1]

As a consequence of these significant revisions, public health educational programs are no longer required to graduate a resultant public health workforce competent in EH. CEPH conducted a trend analysis of the prevalence of EH degree programs and courses among its accredited entities in response to public health faculty members and administrators expressing concern over this deficit.[2] At the time of the survey, 26% of MPH curricula did not require at least one standalone EH course. Among the programs that did not have a discrete EH course, some had reorganized to offer interdisciplinary courses (that might include EH content) as a tactic to meet the current accreditation criteria.

Between 2017 and 2019, EH concentrations or degrees were added to only nine accredited units for the MPH, whereas these concentrations or degrees were removed from 19 accredited units. The latter 19 MPH programs informed CEPH that they had discontinued an EH concentration offering for the following reasons: low or no student enrollment, challenges experienced in complying with the revised accreditation criteria, and insufficient faculty resources to teach this discipline.[2]

The decrease in EH offerings and the revised accreditation criteria pose several challenges for graduate public health education:

1. At the Association for Prevention Teaching and Research Council of Graduate Programs annual meetings, deans and directors have shared their challenges in meeting the criteria for CEPH competency areas because of the prioritization of EH content in their curricula. Thus, programs may choose to remove EH courses and replace them with courses related to CEPH accreditation requirements rather than attempting to meet the competencies through EH courses.
2. The current CEPH accreditation criteria deemphasize EH and may be inadvertently signaling public health programs to do the same.
3. The potential exists for a substantial percentage of current and future graduates to enter (and sustain) the public health workforce without sufficient EH knowledge and competencies to fulfill public health's mission in the age of complex, widespread environmental public health challenges.

This shift in graduate public health curricula affects the EH education of other professionals within the public health workforce. For instance, all preventive medicine residency programs accredited by the Accreditation Council for Graduate Medical Education must include a graduate-level course in EH (or the equivalent) as part of the required MPH degree,[8] and a specific EH course or a syllabus that reflects content equivalent to a free-standing course is required by the American Board of Preventive Medicine for eligibility to take the initial board certification examination. This foundational EH knowledge is considered critical to the practice of preventive medicine, as reflected in the 10% to 15% of board certification questions focused on EH content.[9] According to the executive director of the American Board of Preventive Medicine, the absence of this requisite EH content has delayed approval of initial board certification applications for some recent preventive medicine residency graduates (C. J. Ondrula, oral communication, March 2021).

THE ENVIRONMENTAL HEALTH WORKFORCE AND CREDENTIALING

Our public health system relies on well-trained EH professionals who need to understand essential issues such as the effects of a changing climate on health and need a technical understanding of issues such as food safety. Given that EH professionals account for about 10% of the local (approximately 14 700 employees) and 7% of the state (approximately 6800 employees) health department workforce, they represent a significant proportion of the governmental public health workforce.[10,11] Educational preparation is a timely issue, with 26% of EH professionals working in US health departments potentially retiring over the next 5 years[12] and only 6% of current students pursuing degrees focused on EH content.[13]

The National Environmental Health Association recently collaborated with the Centers for Disease Control and Prevention and Baylor University on a mixed-methods investigation called the Understanding Needs, Challenges, Opportunities, Vision and Emerging Roles in Environmental Health (UNCOVER EH) study. The authors conducted a survey of more than 1700 EH professionals with accompanying focus groups and identified six major priority areas for EH practice: drinking water quality, wastewater management, healthy homes, food safety, vectors and public health pests, and emerging issues. The authors suggested that current academic training in EH is insufficient to meet the extensive demands of the EH workforce, and educational reform was prominent in their recommendations for practice.[14]

The authors of a recent commentary on the alignment of public health academia, professional certification, and public health practice noted the many similarities between the accrediting bodies of schools and programs in public health: CEPH (the credentialing body for public health professionals), the National Board of Public Health Examiners (NBPHE), and the Public Health Accreditation Board (PHAB; the accrediting body for state, local, and tribal health departments). NBPHE offers a certified in public health credential and has certified more than 6000 people since 2008.[15] In 2014, NBPHE embarked on a job task analysis to survey the public health workforce about essential functions and competencies necessary for the public health workforce. PHAB chose to use the 10 essential public health services and three core functions of public health (assessment, policy development, and assurance) as a starting point for its standards.

Although NBPHE and PHAB both have content areas related to EH and human disease risk, the accrediting body for academic public health does not have a competency related to EH.[15] Put simply, we now have public health students who are not required to take an EH course or demonstrate attainment of any EH competencies but who may need this knowledge and these skills to become certified in public health or enter the workforce.

In addition to formal education, once professionals enter the workforce, the registered environmental health specialist and registered sanitarian credentials support professional preparedness through initial competency examinations and continuing education. However, these credentials are inconsistent in their scope, level of training, and requirements within and among states, tribes, and territories. A national standardized format for the two credentials would improve consistency in EH workforce training.[16] Thus, a robust set of EH CEPH competencies would ensure that graduates are prepared to meet these credentialing requirements.

ENVIRONMENTAL JUSTICE

The COVID-19 pandemic has highlighted the significance of the environment for the health of all communities. In many ways, it has provided a new lens for appreciating the wide-reaching impact of the social, natural, and built environment on health. Within this expanded view of the environment, the pandemic has exacerbated inequities that have been ingrained in our society for too long (e.g., poor-quality housing, unfair zoning practices, inadequate workplace safety, deliberate indifference to drinking water contamination). For example, communities of color are more likely than their White counterparts to live near industry, breathe polluted air, and ingest lead-contaminated water.[17–19] When this undue burden of exposure to environmental hazards (and the resultant adverse health outcomes) occurs, often in communities of color, it is due to structural racism and highlights the important work of environmental justice advocates in bringing these inequities to light.

We have also tragically observed that COVID-19 cases and deaths are more likely among people of color, those living in poverty and overcrowded conditions, and those of low socioeconomic status.[20] Challenges associated with climate change adaptation will also further expose vulnerabilities along racial and ethnic lines as marginalized and low-income communities cope with flooding, extreme heat, vector-borne diseases, and other emerging threats if no action is taken to minimize these structural inequities.[20]

How do we expect to combat structural and environmental racism when we are not sufficiently preparing our public health workforce to do the indispensable work of environmental justice? Our public health students must be taught that the “fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income”[21] is critical in working with communities to assess their health with respect to environmental hazards, create EH promotion and disease prevention efforts, and develop and evaluate EH policies. Through our EH classes and programs, we must reinforce application of essential public health services to significant EH threats to understand, address, and prevent environmental health injustice and promote health equity.

ENVIRONMENTAL BURDEN OF DISEASE AND RELATED THREATS

From the epidemiological triangle, we know that the environment is a critical component of disease and a foundation of both epidemiology and public health. Likewise, EH and public health are interconnected foundational pillars that must work together to improve the health of communities and address the tremendous environmental burden of disease (Box 1). In addition, we must understand historical environmental

BOX 1— Major Causes of Morbidity and Mortality Attributable to the Environment

1. Cardiovascular disease
2. Infectious and parasitic diseases
3. Cancer
4. Respiratory disease
5. Road traffic accidents
6. Unintentional injuries
7. Neonatal conditions
8. Mental and behavioral disorders

Source. Prüss-Ustün et al.[22]

events so that we can recognize where we both failed and succeeded in acting swiftly, interprofessionally, and in an evidence-based manner. As educators, it is incumbent that we do not sacrifice meaningful EH content because of an already packed curriculum but instead set EH competencies that ensure public health professionals can effectively prepare for and efficiently respond to EH threats and disasters.

Addressing current and future challenges facing our public health workforce requires competency in toxicology and environmental sciences, among many other areas in EH. The COVID-19 pandemic will force public health leaders to rewrite the textbooks on emergency preparedness and response, infectious disease prevention and control, and vaccination development and administration programs. We will need to rethink how the structures of our physical and social environments influence disease transmission, necessitating a nuanced understanding of topics including bioaerosols, ventilation systems, and even transportation and workplace design.

Since the beginning of the pandemic, public health professionals of all backgrounds have been reengaging with their EH roots as they work directly on the front lines of pandemic response. Public health leaders had to examine how the environment can be changed to lessen transmission through the difficult decisions to close schools and workplaces, issue stay-at-home orders, and require mask use. Facing a deadly novel virus with sparse epidemiological evidence meant that policies had to be grounded in basic environmental science, expert opinion, and principles of environmental justice to reach those most at risk.

This acute need for an academically trained and competent public health workforce equipped with basic EH knowledge, skills, and competency is gaining recognition at the federal level. Within his American Rescue Plan, President Biden immediately called for 1.6 million new public health workers, specifying that 250 000 jobs be devoted to addressing public health crises and “environmental drivers of sickness.”[21] We echo this plan in our call to action for public health programs to reinvigorate their EH courses to meet this need. We must ensure that every public health graduate is competent in basic environmental health science, is grounded in the importance of environmental justice, and is prepared to meet the challenges set forth by President Biden.[23]

CALL TO ACTION

For these reasons, the Association for Prevention Teaching and Research calls on schools and programs in public health and preventive medicine to maintain existing EH content and develop such content if previously eliminated or never offered.[24] We also emphasize the need to ensure that EH content is evidence based and inclusive of past, current, and future EH threats. At the same time, educators need to develop a strategy ensuring that all MPH graduates receive education and training in EH to prepare a competent public health workforce that is ready to address environmental issues. To increase interest and demand, we need to do a better job of explaining the role of the environment in the health of all communities. Preparing our students to understand EH will be critical to counter the pending shortages in the public health workforce.

The reason for teaching EH is not only to ensure the competency of the workforce; it is critical to our students’ understanding of the drivers of health inequities and the fundamental work of the environmental justice movement. As educators, it is our duty to develop future public health practitioners sufficiently prepared to respond to the world’s pressing public health issues, many of which are environmental in origin or involve a significant environmental component. At this moment in our history, we must rededicate ourselves to advocate for those most affected by environmental threats, to promote health equity, and to address structural and environmental racism.

As leaders in public health, we need to work together to advocate that the next revision of the CEPH foundational competencies explicitly include EH. CEPH acknowledges that EH is a foundational learning objective, but environmental health needs to be reflected in the competencies as a value statement to emphasize the indispensable nature of EH knowledge and skills in terms of public health practice. If accreditation standards are revised to more explicitly incorporate EH-related competencies, schools and programs will be incentivized to include EH content that incorporates higher-level learning objectives.

We also need to ensure that EH content is broadly included in the certification in public health examination and other appropriate credentialing and professional examinations for the health workforce. Finally, we need to share our expertise to make it easier for schools and programs to develop rich and engaging EH content. We can collaborate to create examples, case studies, resources, and open access coursework that can be adapted and shared widely via our professional associations (e.g., the Association for Prevention Teaching and Research, the American Public Health Association, the American College of Preventive Medicine, the Association of Environmental Health Academic Programs, and the National Environmental Health Association) to promote high-quality education in EH.

In summary, this past year has been a time of tremendous challenges and adaptations for our public health workforce. Now we urgently need our graduate public health education system to adapt as well. We call on educational leaders to recalibrate our public health educational priorities and emphasize EH to best prepare our future workforce for the inevitable environmental threats we face now and will face for generations to come.

CORRESPONDENCE

Correspondence should be sent to Carly R. Levy, DHS, MPH, CPH, 179 Longwood Ave, Boston, MA 02115 (e-mail: carly.levy@mcphs.edu). Reprints can be ordered at http://www.ajph.org by clicking the “Reprints” link.

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C. R. Levy and L. M. Phillips co-developed the editorial and sketched out the sections. C. R. Levy wrote the workforce and conclusion sections. L. M. Phillips contributed to the section on environmental health threats. C. J. Murray contributed to sections on the scope of the problem and to revisions of the editorial. L. A. Tallon contributed to the workforce and call to action sections and to revisions of the editorial. R. M. Caron wrote the problem statement and coordinated the writing and revisions of the first submission of the editorial.

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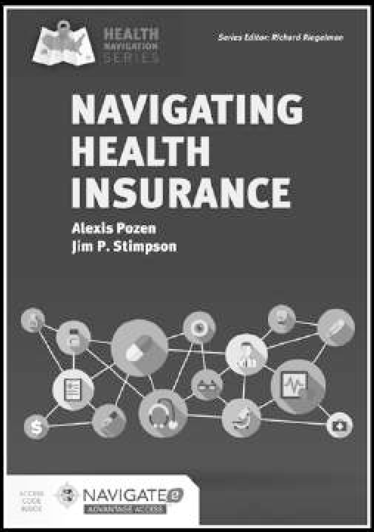

Department Chairs Weigh In: Environmental Health Education Is More Essential Than Ever

Barbara J. Turpin, PhD, Andrea Baccarelli, MD, PhD, Douglas W. Dockery, ScD, Dana C. Dolinoy, PhD, Jonathan I. Levy, ScD, Yang Liu, PhD, Melissa J. Perry, ScD, Justin V. Remais, PhD, and Marsha Wills-Karp, PhD

ABOUT THE AUTHORS

All of the authors are chairs of environmental health and science departments in schools of public health. Barbara J. Turpin is with the Gillings School of Global Public Health, University of North Carolina, Chapel Hill. Andrea Baccarelli is with the Mailman School of Public Health, Columbia University, New York, NY. Douglas W. Dockery is with Harvard T.H. Chan School of Public Health, Harvard University, Boston, MA. Dana C. Dolinoy is with the School of Public Health, University of Michigan, Ann Arbor. Jonathan I. Levy is with the School of Public Health, Boston University, Boston, MA. Yang Liu is with the Rollins School of Public Health, Emory University, Atlanta, GA. Melissa J. Perry is with the Milken Institute School of Public Health, George Washington University, Washington, DC. Justin V. Remais is with the School of Public Health, University of California, Berkeley. Marsha Wills-Karp is with the Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD.

See also Levy and Hernández, p. 48, and Levy et al., p. 69.

We agree with the authors of "Addressing Gaps in Public Health Education to Advance Environmental Justice: Time for Action" (p. 69) that revisions to the Council on Education for Public Health (CEPH) accreditation requirements appear to be having a negative impact on the environmental health education of public health professionals and that there has never been a more important time for such education. As chairs of departments of environmental health, we have observed reductions in environmental health education over the past five years. Many schools no longer require an environmental health course; environmental content has been integrated to varying degrees across other core courses, sometimes with a substantial reduction in content.

We emphasize that environmental health cannot be adequately taught using environmental examples in the teaching of core concepts in biostatistics or epidemiology. Environmental health is not merely a topical area or a series of issues and applications, but a body of theoretical, empirical, biophysical and causal methods that are used to design effective strategies to mitigate the deleterious effects of exposures. Environmental health teaches unique methods to quantify and compare environmental risks, demonstrate the biological plausibility of a potentially causal association, identify the sources of a chemical or biological exposure (i.e., source tracking, source apportionment), and design effective risk mitigation strategies using predictive models based on chemistry, biology, and physics.

Foundational knowledge in these areas is crucial for all public health professionals, not just those specializing in environmental health. In fact, environmental health knowledge is central to many of the major threats being addressed across public health. For example, environmental health methods are needed to understand the roles of ventilation, filtration, exposure time, occupancy, and masking on COVID-19 transmission risk. Although COVID-19 will eventually be behind us, the need to understand the sources and environmental transformations of chemical and infectious agents, routes of exposure, and mechanisms of action to design effective interventions will remain.

Ultimately, climate change is the biggest threat to global public health, including impacts from droughts, floods, fires, heat waves, and hurricanes. Many of these extreme events have further environmental and public health consequences that exacerbate inequities (e.g., toxic releases, air pollution, water insecurity, crop failure, displacement). Cities around the world will be taking steps to reduce carbon emissions (mitigation) and protect populations from climate change (adaptation); all those measures will have health consequences. Educating public health students about the connections between environment, climate, and health is necessary but not sufficient; our students need environmental health tools that enable them to evaluate the benefits of proposed action and advocate optimal approaches.

Furthermore, it is increasingly important for public health students to have a sophisticated understanding of environmental health disparities. Environmental health provides important case examples of the implications of structural racism on health and well-being (e.g., via climate change, COVID-19, lead in drinking water, urban heat islands). Broadly, like the pandemic, climate and environmental change have the potential to have long-lasting and devastating effects on community resilience and health equity. In addressing these challenges, we need educated public health professionals who can help to ensure that the needs of the most vulnerable are centered and that mitigation and adaptation strategies are designed with cobenefits for health equity.

In conclusion, we urge a recentering of the methods of environmental health in public health education. The foundational public health knowledge set forth in the CEPH accreditation criteria only includes "Explain effects of environmental factors on a population's health." This is neither specific nor rigorous. Public health students need knowledge and skills to address the climate crisis, pandemics, and racial injustice, issues that they are truly committed to solving. AJPH

CORRESPONDENCE

Correspondence should be sent to Barbara J. Turpin, University of North Carolina, Gillings School of Global Public Health, 135 Dauer Dr, CB #7431, Chapel Hill, NC 27599-7431 (e-mail: bjturpin@e-mail.unc.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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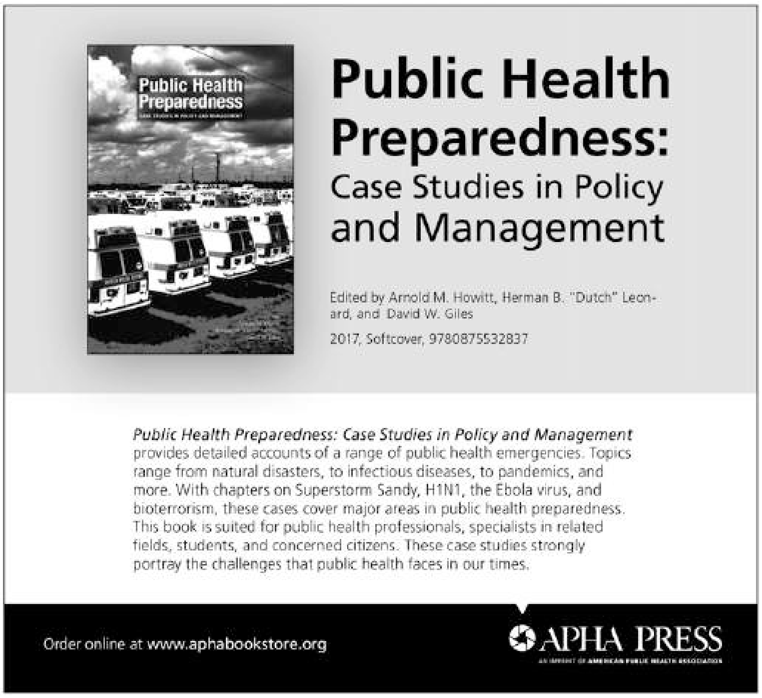

Rethinking Public Health as Sustainability and Environmental Health as Environmental Justice

Tee L. Guidotti, MD, MPH, DABT, and Julie G. Cwikel, MSW, PhD

ABOUT THE AUTHORS

At the time of the writing, Tee L. Guidotti was a member of the editorial board of AJPH. *Julie G. Cwikel is with the Spitzer Department of Social Work and the Center for Women's Health Studies and Promotion, Ben Gurion University of the Negev, Beersheba, Israel.*

See also Levy and Hernández, p. 48, and Levy et al., p. 69.

Environmental health has been the cornerstone of modern public health since the Public Health Revolution of the 1850s. The editorial "Addressing Gaps in Public Health Education to Advance Environmental Justice: Time for Action" by Levy et al. (p. 69) points out that the Council on Education for Public Health has minimized its role as a result of the redefinition of public health competencies in 2016, effectively withdrawing recognition for environmental health as central to public health.

This marginalization is not necessarily obvious because, in 2019, 91% of schools of public health continued to offer environmental health concentrations. However, this was down from 100% before 2016, a drop of almost 10% in three years.[1] Concentration availability does not speak to the subordination of competencies to interdisciplinary educational objectives, which atomizes and diffuses what should be an integrated curriculum of environmental health in master of public health (MPH) programs. Environmental health has a defined body of knowledge and experience[2] that is technically complicated, involves unfamiliar domains of knowledge (such as toxicology), and must be taught as distinct theory and practice with coherency.

Public health, preventive medicine, and health promotion largely emphasize individual behavior and program management. Environmental health rests mainly on collective actions in primary prevention in line with Rose's "population health strategy" model of intervention.[3] The "source–exposure–effect" (SEE) model that resides at the heart of environmental health demonstrates the impracticality of individual behavioral change as the primary strategy for protection from environmental hazards.[2] When key environmental health concepts and content are generalized to fit the paradigms of other concentrations, students lose the opportunity to master the skills they need to address some of the most important, interrelated, and rapidly emerging exposure-related challenges we face: emerging infectious disease hazards, primary and interactive effects of pollutants, and local effects of toxic exposures.

Borrowed and incomplete paradigms are even less well suited to environmental health problems of a complex, interdisciplinary, and emergent nature, including climate change, disaster response and emergency management, local ecosystem viability, global health and development, and urbanization. Without an integrated framework for environmental health, there is no place to tie the loose ends.

The current discussion does open an opportunity for rethinking environmental health for a new era. Climate change is the most critical of a large set of problems involving ecosystem change and long chains of causation. These issues are not easily analyzed with the SEE model. They are more amenable to methods of analysis that arise from decision-making models and risk science than to classical epidemiology, and they require tools that are more versatile. One way forward would be to reach out to the community of scholars in environmental studies, environmental sciences,[4] social epidemiology,[5] and the emerging field of sustainability research,[6] who are potential expert collaborators and are motivated by environmental justice as a core organizing principle.

Environmental health does need to incorporate more social and behavioral science[5,6] but in the specific applications of risk communication, motivating concerted action at a societal level, and root cause analysis,[7] not in motivating individual behavioral change. Public health education at the MPH level needs to promote recognition of the importance of multidisciplinary models in imagining solutions to so-called "wicked problems," which are by definition complex, intertwined, system driven, and refractory.[7]

The common wrap-around for all of these issues should be sustainability. Sustainability, ensuring continuity and sufficiency for future generations, means protecting the health of individuals and the community, mitigating the health impact of catastrophic global change, ensuring the viability of communities and the services that support them, and advocating for environmental justice through the right of all people to live a decent life in the face of existential threats. Sustainability is a unifying concept for all public health and a better strategy than redefining environmental health within the domains of other disciplines. AJPH

CORRESPONDENCE

Correspondence should be sent to Tee L. Guidotti, MD, MPH, DABT, Occupational + Environmental Health & Medicine, c/o Advanced Technologies and Laboratories International, 555 Quince Orchard Rd, Gaithersburg, MD 20878, (e-mail: tee@teeguidotti.com). Reprints can be ordered at http://www.ajph.org by clicking the “Reprints” link.

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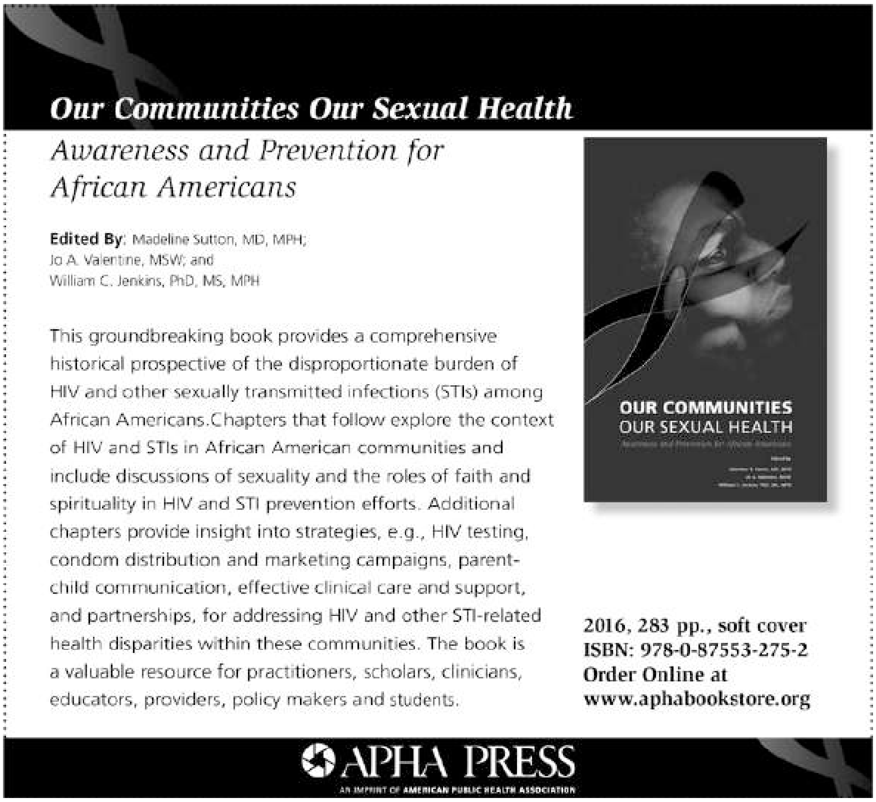

Queering Environmental Justice: Unequal Environmental Health Burden on the LGBTQ+ Community

Leo Goldsmith, MEM, and Michelle L. Bell, PhD

See also Levy and Hernández, p. 48, Collins et al., p. 54, and Gaard, p. 57.

The LGBTQ+ (lesbian, gay, bisexual, transgender/-sexual, queer or questioning, intersex, asexual, and all subsects) population has been the target of federal and state discriminatory policies leading to high levels of institutional discrimination in the housing, employment, and health sectors. Social determinants of health such as housing conditions, economic opportunities, and access to health care may negatively and disproportionately affect the LGBTQ+ population and reduce their capacity to respond to environmental harm (e.g., obtaining necessary medical care).

Social determinants of health have been shown to be associated with unequal harmful environmental exposure, primarily along lines of race/ethnicity and socioeconomic status. However, chronic diseases, such as respiratory diseases, cardiovascular disease, and cancer, associated with environmental exposure have been shown to occur in higher rates in the LGBTQ+ population than in the cisgender, heterosexual population.

We explore how environmental exposures may disproportionately affect the LGBTQ+ population through examples of environmental exposures, health risks that have been linked to environmental exposures, and social institutions that could affect resilience to environmental stressors for this population. We provide recommendations for policymakers, public health officials, and researchers.

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The LGBTQ+ (lesbian, gay, bisexual, transgender/-sexual, queer or questioning, intersex, asexual, and all subsects) community is a diverse population of at least 14 million individuals in the United States alone.[1] Evidence indicates that sexual and gender minorities, as with other marginalized populations, experience health inequalities stemming from social determinants of health. LGBTQ+ persons have higher levels of homelessness, unemployment, lack of health care, and identity-based violence than do cisgender, heterosexual populations.[2] Discrimination faced by LGBTQ+ persons is part of the more encompassing environmental health inequities of race/ethnicity, socioeconomic position, disability, rurality, and more. Although intersectionality is increasingly recognized, most research to date has focused on the cisheteronormative White experience, particularly the male experience.[3] Intersectionality is not fully incorporated into research or discussions on environmental justice in public health,[4] yet LGBTQ+ persons who are also members of other marginalized groups are particularly vulnerable.

Environmental justice studies focus on intersections between environmental exposure, marginalized subpopulations, and health disparities. Scholars in this field have validated the experiences of racial minorities by demonstrating links between environmental exposures, geography, race, and socioeconomic status.[5] Toxic industries and sources of air pollution have consistently been located in communities of color.[6] Although the study of environmental justice has expanded to include women, indigeneity, citizenship, and more, far less attention has been paid to sexual orientation and gender identity, including in the context of intersectionality. For example, LGBTQ+ people of color may experience environmental injustices related to race/ethnicity, as would their cisgender and heterosexual counterparts, in addition to any disproportionate burden of the LGBTQ+ population.[7]

There is insufficient research on associations between environment and health inequalities in LGBTQ+ populations, despite higher rates of chronic physical and mental illnesses.[8] Only a few studies have been conducted on LGBTQ+ populations and environmental exposures such as air pollution, secondhand smoke, and environmental disasters.

There are many ways that LGBTQ+ persons face disproportionate environmental health burdens. Figure 1 depicts an environmental justice LGBTQ+ framework loosely based on the environmental justice race/ethnicity framework proposed by Gee and Payne-Sturges.[9] This figure depicts several pathways through which LGBTQ+ persons could face environmental health disparities. Social institutional and structural factors include discrimination affecting community of residence and housing options, employment, and access to appropriate health care formed through cisheteronormative federal, state, and local policies. Employment affects options for housing, health care, and mental health and well-being.

Individual factors include behavior, such as proximity to secondhand smoke, and underlying health conditions, including HIV, respiratory distress owing to chest binding, and mental factors. All of these could affect environmental exposures, for example, from occupational exposures, community-based exposures (e.g., ambient air pollution), and exposure to environmental disasters in relation to discriminatory disaster relief programs.

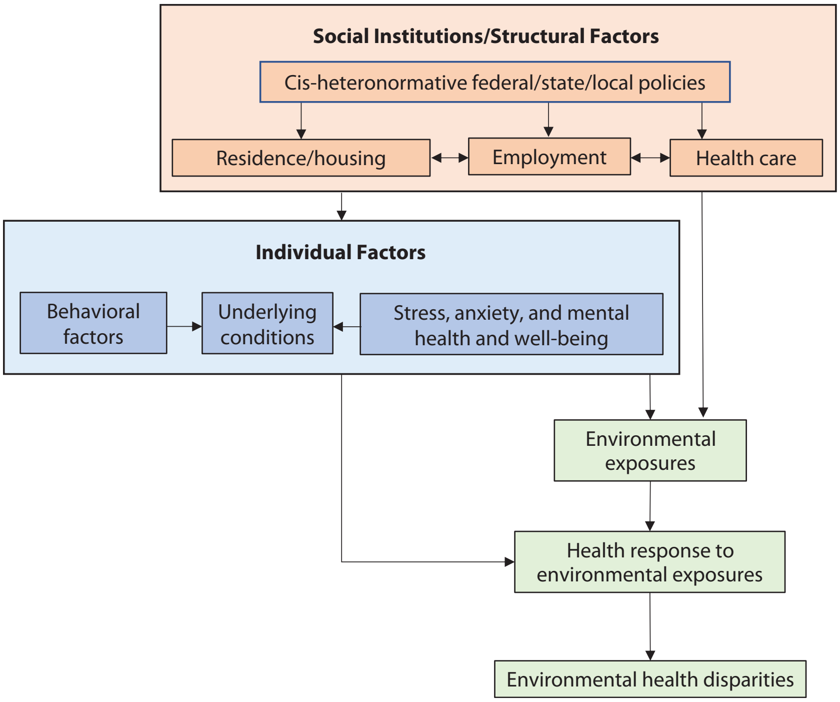

FIGURE 1— Conceptual Framework for Environmental Health Disparities for the LGBTQ+ Population

Note. LGBTQ+ = lesbian, gay, bisexual, transgender/-sexual, queer or questioning, intersex, asexual, and all subsects. This schematic depicts the social institution and structural factors and individual factors that relate to pathways through which LGBTQ+ populations could suffer disproportionate public health burden from environmental stressors. The figure is not intended to show all pathways or links between these factors.

In addition to differential exposures, LGBTQ+ populations may have a different health response to those exposures (referred to as effect modification in epidemiology), for example, because of underlying health conditions or inability to mitigate adverse health effects through medical services. Collectively, these factors could lead to environmental health disparities for LGBTQ+ persons. This conceptual framework does not capture all factors and interconnections among these factors. For example, underlying health conditions could contribute to stress, as would discrimination and violence. Housing practices may affect employment opportunities. Intersectionality with other marginalized groups would further contribute to environmental health disparities.

We explore several examples of these pathways with respect to social institutions, environmental exposures, and health outcomes. Despite little relevant research, we conclude that there are multiple pathways through which environmental exposures and associated health impacts may disproportionately affect LGBTQ+ persons. We provide recommendations for policy, practice, and research.

SOCIAL INSTITUTIONS

Discrimination through social institutions may lead to disproportionate environmental health outcomes for the LGBTQ+ community. Here we describe 2 examples: health care and employment, although many other cases exist, such as discriminatory housing policies and responses to environmental disasters, which we discuss in a later section.

Health Care

LGBTQ+ persons often face disadvantages in receiving health care. They are less likely to seek medical care until they have a serious health issue because of fear of discrimination or cost, are less likely to have health insurance, and experience extensive mistreatment or discrimination from health professionals.[10] One study found that 1 in 6 LGBTQ+ adults avoided seeking health care because of anticipated discrimination.[11] In 2015, 33% of transgender individuals were either verbally harassed or refused medical care.[12] These stark realities may place the LGBTQ+ population in a more vulnerable position when subjected to the health outcomes from environmental exposures if they are less willing or able to find or receive comprehensive care from health care providers.

Employment

The LGBTQ+ population is more susceptible to unemployment than is the non-LGBTQ+ population and are more likely to work in certain occupations. Unemployment can place individuals in poverty, which is associated with exposure to environmental pollution and injustice. One study found that 9% of LGBTQ+ individuals are unemployed in the US compared with 5% of cisgender, heterosexuals.[13] The unemployment rate for transgender individuals is 15%, corresponding to nearly one third of transgender individuals living in poverty compared with 14% of the general population.[12]

LGBTQ+ individuals also work in industries disproportionately affected by occupational hazards that are associated with respiratory illnesses. Forty percent of LGBTQ+ individuals work in 5 industries (restaurant and food services, retail, hospitals, K–12 education, and colleges and universities) compared with 22% of cisgender, heterosexual individuals.[14] Although this issue is understudied, the different distribution of occupational hazards and higher unemployment for the LGBTQ+ community, which relates to lack of access to health care and housing and other health stressors, plausibly relates to different health consequences for environmental exposures.

ENVIRONMENTAL EXPOSURE

We explore 3 examples of environmental exposures that may disproportionately affect LGBTQ+ persons: ambient air pollution, environmental disasters, and secondhand smoke. These issues relate to different levels of exposures, as well as the impacts and discrimination encountered by the LGBTQ+ population during environmental disasters.

Air Pollution

Ambient air pollution varies among and in communities. Where LGBTQ+ people live, just as any other population, affects their exposures. After World War II, “heteronormative NIMBYism,” where locally unwanted land uses such as gay bars and businesses were excluded from heterosexual spaces, was common.[15] This may have led to other locally unwanted land uses being located in LGBTQ+ spaces, as occurred for racial/ethnic minority communities. Around this time, the Federal Housing Administration prioritized housing loans for married couples that proved they were in a “fit” marriage, preventing accumulation of generational wealth for LGBTQ+ persons and thus affecting their ability to afford housing.

Exclusive policies in urban planning also pushed LGBTQ+ individuals into low-income, declining neighborhoods.[16] “Gayborhoods” often have few LGBTQ+ residents because high property values create the illusion that the LGBTQ+ population is primarily White, cisgender, affluent, gay men. This renders others in the community invisible to possible exposure and impact. Currently, 29 states have no antidiscrimination housing policies, and the Federal Housing Act and Equal Credit Opportunity Act does not explicitly prohibit discrimination against sexual orientation and gender identity.[2] The Department of Housing and Urban Development has antidiscrimination policies for LGBTQ+ individuals, but as of 2019 male same-sex couples still experienced discrimination when seeking mortgages from the Federal Housing Administration.

These differences and this discrimination could lead to different environmental exposures that vary by community. LGBTQ+ persons may have higher health impacts from air pollution because of where they live, although this exposure also presents a large public health burden for the general population. More than a 100 000 000 people live in areas exceeding the US Environmental Protection Agency’s health-based standards for ozone and fine particulate matter.[17]

Evidence on disproportionate exposure from air pollution is limited—another example of a research gap in identifying residences of LGBTQ+ populations—but the existing research suggests potential disparities. Two studies, conducted by the same research team, used census data on same-sex couples and hazardous air pollution (HAPs) data from the National Air Toxics Assessment. These studies examined same-sex enclaves for census tracts with a high proportion of same-sex couples using a K-means cluster analysis. Such enclaves were defined as census tracts in the highest fifth percentile for households where 2 people of the same sex lived together in a domestic partnership. In one such study, the authors proposed that heterosexist urban planning may explain the presence of same-sex couple enclaves and their unequal exposure to areas with high HAPs.[15] In that work, based in Greater Houston, Texas, census tracts with same-sex enclaves had a higher estimated risk of cumulative cancer from HAPs. Another study found that the HAPs levels were higher in areas where same-sex couples lived than in areas where opposite-sex couples lived.[18] Based on different models, same-sex enclaves were associated with a 9.8% to 13.3% higher risk of respiratory illnesses and cancer. Results indicated that sexual orientation, even when accounting for other confounders such as race, is a strong indicator of living in an area with high levels of HAPs.[15]

There are other pathways through which the LGBTQ+ population may be vulnerable to the health impacts of air pollution. It is lifesaving and gender affirming for some transgender and nonbinary individuals to chest bind to make their chests appear flatter. Doing so helps prevent mental anguish in the form of anxiety, depression, and suicidal ideation; however, chest binding can also cause abnormal lung function.[19] Although researchers have not yet investigated this issue, detrimental lung function from chest binding for transgender and nonbinary individuals may increase the risk of respiratory impacts of environmental exposures, such as air pollution.

Environmental Disasters

Environmental disasters such as hurricanes and wildfires also may disproportionately affect LGBTQ+ health; this is owing to hindered access to resources and inclusion in disaster response policies and protocol. Although this is understudied, the existing evidence suggests a higher burden. For example, environmental disasters were associated with increased physical violence against LGBTQ+ individuals.[20]

One report describes the unique marginalization and vulnerabilities of LGBTQ+ populations during Hurricane Katrina: LGBTQ+ persons were blamed by some religious leaders for the disaster and excluded from disaster response policies; additionally, they lacked benefits given to married heterosexual couples, did not receive adequate health care particularly if HIV positive, and faced stigma and discrimination.[21] Two Black transgender women were arrested for using the bathroom of their gender at an emergency temporary shelter, which highlights the added layer of intersectionality. Other transgender individuals were denied aid from faith-based organizations for not possessing identification that matched their name or gender. Federal Emergency Management Agency's lack of recognition of LGBTQ+ families led to unequal distribution of resources, often to the detriment of their children.[22]

Section 308 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act currently does not protect sexual orientation or gender identity. The US Department of Department of Housing and Urban Development update to the Equal Access Rule, announced July 1, 2020, prohibits discrimination to Department of Housing and Urban Development–funded housing services, such as temporary emergency shelters during disasters, based on sexual orientation or gender identity, but specifically allows shelters to "voluntary establish a policy," leaving these persons open to discrimination.

Research on this issue has been limited and primarily not based in the United States. Sexuality and gender identity are very different in cultures and countries that do not subscribe to Western ideas of sex and gender.[23] Therefore, we refer to these non-US populations as sexual and gender minorities rather than LGBTQ+. A study synthesizing 12 articles found that gender minorities worldwide faced physical, sexual, and emotional violence from environmental disasters and lacked support from governmental agencies.[23] During the 2020 Haitian earthquake, sexual and gender minorities were denied access to emergency housing and disaster relief services, as occurred during Hurricane Katrina, leaving them more vulnerable to the disaster.[21] During the 2011 Queensland, Australia, floods, 43% of LGBTQ+ individuals felt afraid in places such as streets, parks, and evacuation centers during the disaster and recovery.[24] More research on the LGBTQ+ population in the United States may show similar occurrences.

Secondhand Smoke

Smoking is an environmental justice concern for LGBTQ+ populations because of their higher exposure to respiratory pollutants and secondhand smoke, both of which exacerbate respiratory illnesses. A study based in California found that homosexual women, bisexual women, and homosexual men were much more likely to smoke cigarettes than were heterosexual individuals.[25] The smoking rate of homosexual women was 70% more than the rate of heterosexual women. Other studies have shown that the transgender population also has higher rates of cigarette use than does the cisgender population. Transgender men have the highest past 30-day use rate of cigarette, e-cigarette, and cigar use among transgender populations. Transgender men are twice as likely as cisgender men and 3 times as likely as cisgender women to use cigarettes or e-cigarettes.[26]

Minority stress, targeted advertising by tobacco companies, and gender stereotypes may contribute to health disparities related to cigarette smoking.[27] A systematic review of risk factors of smoking in the lesbian, gay, and bisexual population found that different smoking rates may relate to factors unique to this population: internalized homophobia, negative reactions to disclosure of sexual orientation, and identity within the sexual minority community.[28] Factors that are not unique to, but occur at higher rates in, the lesbian, gay, and bisexual population and could lead to higher smoking rates include stress, depression, alcohol use, victimization, lack of support networks, and low socioeconomic status.

These higher rates of smoking among the LGBTQ+ community mean higher exposure to secondhand smoke where they live, work, and socialize. A study using the California Health Survey found that sexual minority men and women are twice as likely to be exposed in their own household to secondhand smoke.[29] Another study found that homosexual women are more exposed to secondhand smoke in the workplace and bisexual women are more exposed in their home than women in different-sex relationships.[30] Patrons of LGBTQ+ bars and venues had 38% higher odds of being exposed to secondhand smoke than did visitors of non-LGBTQ+ bars and venues.[31]

HEALTH OUTCOMES

We explore 3 examples of health outcomes that disproportionately affect LGBTQ+ populations and have links to environmental stressors: HIV, respiratory illness, and mental health. These health outcomes may also be exacerbated or stigmatized in response to environmental conditions.

HIV

HIV is one of the most studied health outcomes that disproportionately affect LGBTQ+ persons, and environmental conditions have been shown to exacerbate HIV. Cisgender gay men, cisgender bisexual men, and transgender individuals are more likely to develop HIV. Gay and bisexual men comprise 55% of HIV cases but comprise only 2% of the US population.[32] Having an intersectional racial minority identity is associated with higher rates of HIV. Half of Black gay and bisexual men have HIV. Transgender women are greatly affected, particularly if they are Black.[33]

Several studies investigated how environmental exposures may exacerbate HIV. Air pollution can cause and worsen conditions such as pneumocystis pneumonia and tuberculosis (TB), leading to complications in HIV-positive individuals. For example, exposure to PM_{10} (particulate matter with a diameter of ≤ 10 micrometers), nitrogen dioxide, and ozone has been associated with an increased risk of pneumocystis pneumonia hospitalization in people with HIV.[34]

In 2014, 33% of people with HIV had TB—one of the deadliest communicable diseases.[34] A study in Spain of HIV patients using combined antiretroviral therapy between 1997 and 2012 found that nitrogen dioxide and sulfur dioxide exposure were associated with a risk of hospital admission related to TB.[34] A study in Northern California found a positive association between carbon monoxide and nitrogen dioxide exposure and contracting TB.[35] Thus, populations with high rates of HIV are particularly susceptible to poor health consequences from exposure to air pollution.

Respiratory Illnesses

The LGBTQ+ population is at higher risk for respiratory illnesses such as asthma and chronic obstruction pulmonary disease, which are diseases related to environmental exposures such as air pollution and smoking. Same-sex couples had higher rates of lifetime and current asthma than did heterosexual couples; these higher rates are related to higher rates of obesity among homosexual women as well as higher rates of smoking, stress, and victimization.[28] However, environmental conditions, such as air pollution, also can cause asthma and related complications by increasing lung inflammation.[36] Some other health outcomes related to the environment are higher in LGBTQ+ populations; one study found that the risk of chronic obstruction pulmonary disease was significantly higher for the LGBTQ+ population except for transgender men. The authors attributed sleep deprivation as 1 of the chronic obstruction pulmonary disease risk factors,[37] although disproportionate burden from air pollution has not been studied.

Mental Health

Mental health issues have been linked with multiple environmental conditions, which may put the LGBTQ+ population at higher risk or exacerbate existing inequalities. LGBTQ+ persons experience higher levels of mental illnesses than do the cisgender, heterosexual population. Institutional and social-based discrimination and stigma contribute to unique internalized anguish that affects LGBTQ+ populations.[38] The LGBTQ+ population struggles with expectation of rejection because of their identity, concealment of their identity, and internalized homophobia, factors leading to higher levels of mental illnesses. In the LGBTQ+ population, transgender individuals of all sexualities face more mental health burden than do cisgender lesbian, gay, and bisexual individuals, with 40% of the transgender population experiencing psychological distress.[16]

Mental health conditions can be aggravated by environmental conditions, including air pollution, weather, environmental disasters, and noise. For example, air pollution can exacerbate mental illness in populations with high rates of psychological distress attributable to minority stress. Long-term exposure to air pollution was found to increase the odds of depression.[39] Although this issue remains unstudied, environmental stressors contributing to mental health may be particularly harmful for the LGBTQ+ population, which already face higher levels of mental health burdens.

ADDITIONAL PATHWAYS

Despite limited research, there exist multiple pathways through which the LGBTQ+ population could face disproportionate health burdens from environmental conditions. The examples provided here for social institutions (i.e., health care and employment), exposures (i.e., air pollution, environmental disasters, and secondhand smoke), and health outcomes (i.e., HIV, respiratory illness, and mental health) are meant to be illustrative, not an exhaustive discussion of the potential harm. As an example of another potential link, cardiovascular disease (CVD) risks are higher for some LGBTQ+ subgroups and are linked to environmental conditions. One study found higher CVD risk for bisexual men than heterosexual men.[40] Another study found that same-sex women living together have higher risk of CVD mortality than do women living with opposite-sex partners.[41] CVD is the leading disease-specific cause of death for transgender and nonbinary individuals receiving gender-affirming treatment.[42] Transgender women are more likely to suffer CVD mortality than are transgender men and cisgender men and women.[42] Although CVD has been linked to many environmental contaminants, such as air pollution, the potential effect of environmental exposures on CVD outcomes for the LGBTQ+ population is unknown.

INTERSECTIONALITY

The examples of societal institutions, environmental exposures, and health outcomes discussed here do not act in isolation (Figure 1). For instance, many chronic illnesses and conditions, such as HIV and poor mental health and well-being, that disproportionately affect LGBTQ+ populations may synergistically interact with HAPs.[10] As another example, bacterial or fungal infestation of housing materials after a flood could affect people with HIV, causing respiratory illnesses such as pneumonia, asthma, and fevers.[43] One study recommends that after a hurricane or a major flood, people who are immunocompromised should only go near a moldy building with respiratory protection and avoid handling any of their contaminated belongings.[44]

Another environmental disaster, wildfires, release fungi from soils that cause the disease coccidioidomycosis (valley fever), which can affect the immunocompromised and cause pneumonia and tissue destruction.[45] Furthermore, given their compromised immunity, people with HIV are particularly affected by poor quality air and water and during environmental disasters can suffer disproportionately from lack of lifesaving medications and lack of access to health centers.[46] LGBTQ+ individuals who do not have access to lifesaving medications for HIV or hormone replacement therapy during environmental disasters may not seek aid for fear of discrimination.[47] During Hurricane Maria, many pharmacies were destroyed or did not have electricity. Working with limited telecommunications, pharmacists were unable to reach providers to update prescription refills or reach those needing medication.[48] During Hurricane Katrina, LGBTQ+ individuals with HIV were reluctant to disclose their status and deal with emergency relief doctors who were unfamiliar with treating patients with HIV.[22] There is a lack of inclusive and thoughtful disaster response policies for the LGBTQ+ population.

LGBTQ+ persons of color may be at particular risk because of environmental justice concerns overlapping with race/ethnicity concerns, as minorities face well-established higher environmental health burdens. A US Department of Agriculture report concluded that LGBTTQ (lesbian, gay, bisexual, transgender, 2-spirit, and queer) communities have added layers of trauma, discrimination, and stigma from colonization, but also gender and sexuality can place them in a vulnerable position in environmental disasters.[49] Intersectionality of environmental justice risk factors cause some portions of the LGBTQ+ population to be particularly vulnerable.

RESEARCH AND DATA GAPS

Lack of research on where LGBTQ+ individuals live challenges the investigation of their potentially disproportionate exposure to spatially heterogenous environmental contaminants, such as air pollution (e.g., proximity to traffic-related pollutants). To date, data on LGBTQ+ residence is limited. The largest survey of where people live in the United States is the US Census and the American Community Survey. These surveys collect demographic information such as race/ethnicity, income, and limited gender information, but they have not explicitly collected data on sexual orientation or gender identity. The only information on sexual orientation that can be gathered from these data are same-sex partnerships. Same-sex households are calculated by pairing households in which 2 people of the same-sex live together and have documented that they are in a domestic partnership. This omits LGBTQ+ partners that do not live together, single LGBTQ+ people, bisexual individuals in opposite-sex partnerships, and many transgender individuals.

There are additional barriers to acquiring LGBTQ+ population data. Institutional discrimination can lead to LGBTQ+ individuals concealing their identity. Sexual orientation and gender identity can be fluid and change over time. Individuals figuring out their sexual orientation or gender identity may switch how they identify over time, and there are transgender individuals who are gender fluid or variant. To fully understand sexual orientation, researchers need to understand identity, attraction, and behavior. Most federal surveys ask only for identity. Including attraction and behavior in surveys can help identify individuals who may not identify as lesbian, gay, or bisexual but may be attracted to or have sexual intercourse with the same sex. This is especially true for many subcultures in which one may not identify as lesbian, gay, or bisexual depending on sexual position.

PUBLIC HEALTH IMPLICATIONS

To further understand and address the potential disproportionate health burden of environmental exposure on the LGBTQ+ population, we recommend both further research and actions to address the underlying discrimination. The following are some specific recommendations for policy, practice, and research:

1. Implement LGBTQ+ antidiscriminatory policies in health care facilities and provide cultural competency for health care workers and mental health professionals. This should include training on LGBTQ+ issues and care.
2. Implement policies to aid the ability of transgender and nonbinary individuals to obtain appropriate identification documents such as driver's licenses and passports with their name and gender identity.
3. Implement federal, state, and local nondiscrimination policies in sectors such as housing, employment, and health.
4. Target the LGBTQ+ communities in tobacco cessation ads and campaigns.
5. Develop partnerships between government agencies at all levels (municipal, state, and federal) and LGBTQ+ organizations for disasters response and relief to address access and discrimination.
6. Incorporate LGBTQ+ issues into environmental justice research and organizations.
7. Develop and implement a system of collecting sexual orientation and gender identity data that is consistent and addresses the complex nature of the LGBTQ+ population. Such a data set needs to include variables that would help researchers assess environmental exposures (e.g., exact residence or area of residence, such as zip code) and intersectionality of risk (e.g., low income, race/ethnicity). This would provide the means to research environmental injustice and health in the LGBTQ+ population and compare them with other populations, especially for spatially based environmental hazards (e.g., air pollution).

In summary, there exist multiple, interconnected pathways through which LGBTQ+ persons may suffer disproportionate health burdens from environmental stressors, including differences in exposures and health responses, with links to social institutions and entrenched discrimination that affect many aspects of LGBTQ+ lives, such as education, health care, and access to resources during an environmental disaster. Further research and response are needed to better protect the LGBTQ+ population to address potential environmental inequities as well as the underlying discrimination and stigma that contributes to such inequities. AJPH

ABOUT THE AUTHORS

Leo Goldsmith and Michelle L. Bell are with the School of the Environment, Yale University, New Haven, CT.

CORRESPONDENCE

Correspondence should be sent to Michelle Bell, Yale University, School of the Environment, 195 Prospect St, New Haven, CT 06511 (e-mail: michelle.bell@yale.edu). Reprints can be ordered at http://www.ajph.org by clicking the “Reprints” link.

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M. L. Bell supervised the project. Both authors conceptualized the presented idea and wrote and edited the essay.

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The authors have no conflicts of interest to report.

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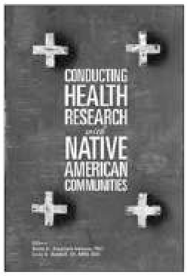

Inequities in Drinking Water Quality Among Domestic Well Communities and Community Water Systems, California, 2011–2019

Clare Pace, PhD, MPH, Carolina Balazs, PhD, Komal Bangia, MPH, Nicholas Depsky, MS, Adriana Renteria, BA, Rachel Morello-Frosch, PhD, MPH, and Lara J. Cushing, PhD, MPH

See also Levy and Hernández, p. 48.

Objectives. To evaluate universal access to clean drinking water by characterizing relationships between community sociodemographics and water contaminants in California domestic well areas (DWAs) and community water systems (CWSs).

Methods. We integrated domestic well locations, CWS service boundaries, residential parcels, building footprints, and 2013–2017 American Community Survey data to estimate sociodemographic characteristics for DWAs and CWSs statewide. We derived mean drinking and groundwater contaminant concentrations of arsenic, nitrate, and hexavalent chromium (Cr[VI]) between 2011 and 2019 and used multivariate models to estimate relationships between sociodemographic variables and contaminant concentrations.

Results. We estimated that more than 1.3 million Californians (3.4%) use domestic wells and more than 370 000 Californians rely on drinking water with average contaminant concentrations at or above regulatory standards for 1 or more of the contaminants considered. Higher proportions of people of color were associated with greater drinking water contamination.

Conclusions. Poor water quality disproportionately impacts communities of color in California, with the highest estimated arsenic, nitrate, and Cr(VI) concentrations in areas of domestic well use. Domestic well communities must be included in efforts to achieve California's Human Right to Water.

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Drinking water crises in Flint, Michigan,[1] and Newark, New Jersey,[2] have highlighted the lack of universal access to safe drinking water in the United States. Roughly 10% of California's public drinking water systems are currently out of compliance with state drinking water quality standards, and an estimated 6 million Californians are served by systems that have been in violation at some point since 2012.[3] A disproportionate number of water quality violations in the state occur in smaller drinking water systems that serve rural, low-income communities, where degraded infrastructure and a lack of resources make it challenging to meet regulatory standards.[4–8] Communities served by water systems with elevated contaminant levels are disproportionately poor and Latinx, raising environmental justice concerns.[6,7,9]

In 2012, California passed Assembly Bill 685,[10] known as the Human Right to Water law, which recognizes the universal right to clean, safe, affordable drinking water for all, including communities served by community water systems (CWSs, defined as systems with at least 15 service connections or serving at least 25 year-round residents), state small water systems (5–14 service connections), and domestic wells and small systems (<5 service connections, referred to herein as "domestic wells").[11] One barrier to achieving universal access to clean drinking water is lack of information on the location of domestic wells, which fall outside the purview of state and federal drinking water regulations.[12,13] Communities served by domestic wells often face significant water-quality challenges compared with CWSs as domestic wells commonly serve rural, agricultural, and socioeconomically disadvantaged communities.[14] While CWSs are required to monitor for select drinking water contaminants under the Safe Drinking Water Act, monitoring of domestic wells is unregulated.

In this analysis, we provided a fine-scale estimate of the locations of domestic well communities in California and estimated groundwater quality in those areas and in delivered water from CWSs. We characterized relationships between community sociodemographics and water quality among both domestic well and CWS populations. We did not differentiate state small water systems from domestic well areas because of the paucity of data on these systems' locations. We focused on 3 chemical contaminants selected because of evidence of statewide prevalence and toxicity:[4,9,15] arsenic, nitrate, and hexavalent chromium (Cr[VI]). Each of these contaminants can cause significant health effects.[16–18] Arsenic occurs naturally in groundwater, and concentrations increase with land subsidence from industrial and agricultural activities.[19,20] Nitrate contamination is common in agricultural regions because of fertilizer runoff and industrial animal operations.[21] Cr(VI) enters groundwater from industrial and manufacturing activities.[22]

METHODS

We combined multiple secondary data sources to identify drinking water sources, estimate the drinking water quality and characteristics of communities served, and estimate associations between average contaminant concentrations and community sociodemographic variables.

Community Water Systems

We obtained service area boundaries from the Tracking California Drinking Water Systems Geographic Reporting Tool[23] for CWSs listed as active in California's Safe Drinking Water Information System as of 2018.[24] We removed duplicates and assigned any overlapping service areas to the CWS with the smaller service area because smaller systems were often entirely within larger systems' boundaries. We excluded service area boundaries for wholesale water systems that do not directly serve consumers, but included water purchased from wholesalers in our water quality estimates.

Domestic Well Areas

We obtained records for more than 900 000 wells drilled in California between 1927 and 2018 from the Department of Water Resources' Online System for Well Completion Reports.[25] Most well locations were reported by the Public Land Survey System (PLSS) section (a roughly 1 × 1 mile square) within which they were located, so we approximated their spatial coordinates using the corresponding PLSS section centroid. We retained more precise location information for a small subset of wells with records that reported latitude and longitude with an estimated accuracy of within 50 feet of the true coordinates.[25]

To identify domestic well areas (DWAs), we excluded unpopulated Census blocks according to the 2010 decennial Census. We excluded PLSS sections without wells and PLSS sections entirely within the boundary of a CWS (which assumes domestic wells within a CWS service area were not in use). We used a high-resolution, statewide map of populated areas created via dasymetric mapping to refine DWA locations by excluding unpopulated space within geographic Census unit boundaries.[26] This population layer was created by using (1) 2010 decennial Census (block boundaries and population totals) and 2013–2017 American Community Survey (ACS) data (block group population totals), (2) a statewide database of residential parcel boundaries,[27] and (3) a building footprints layer developed by Microsoft.[28]

For each Census block, we used spatial downscaling methods to disaggregate population values to subblock geometries. In method 1, residential parcels were identified from the parcel data set and used as the boundaries of populated areas within each block. This assumes populations are uniformly distributed across residential parcels rather than across the entire block. This technique was applied to Census blocks containing 91.8% of the state's population. In method 2, for populated Census blocks that did not contain residential parcels, individual building boundaries within the block were identified using Microsoft's building footprint data set. This assumes that for blocks with a nonzero population but with no residential parcels, population is uniformly distributed among the buildings within these blocks. This method was applied to blocks containing 7.9% of the state's population. For the blocks containing the remaining 0.3% of the state's population, with neither residential parcels nor building footprints, no downscaling was applied, with the assumption that those populations are uniformly distributed across the entire block area. The result was a statewide map of populated areas downscaled within Census blocks. This map was intersected with PLSS sections to create our final geographic units of analysis: 1914 populated portions of Census block groups served by domestic wells (Figure 1).

Sociodemographic and Population Variables

We derived population estimates for DWAs and CWSs by using the 2010 decennial Census and the 2013–2017 ACS. Population estimates at the block level were last enumerated in the 2010 decennial Census, with values at the parent block-group level updated annually via the ACS. For data vintage consistency, we scaled block-level population values according to population growth rates observed in parent block groups between 2010 and the 2013–2017 ACS. These block populations were assigned to the reduced block populated area boundaries identified via dasymetric mapping as described previously.

To assign population estimates to DWAs and CWSs, we summed the population within each populated area in each block. Because CWSs commonly encompass many blocks, we aggregated the population from each block to CWSs. This approach distributes the population in Census blocks that serve both DWAs and CWSs to their respective water systems without double counting population and assigns 98.8% of the total Census population a water source (Figure A, available as a supplement to the online version of this article at http://www.ajph.org).

Sociodemographic characteristics expressed as mean or median values (not counts) were assigned to populated areas using 2013–2017 ACS block-group level value, with a parent block group's value applying equally to all of its blocks. To calculate the value of these characteristics for DWAs and CWSs, we derived weighted averages using the population contribution of each Census block within the CWS or DWA boundary relative to the total CWS or DWA population as the weights:[29]

$$W = \frac{\sum_{i}^{n} w_i X_i}{\sum_{i}^{n} w_i} \qquad (1)$$

where W is the weighted average sociodemographic variable for the CWS or DWA, w_i is the population weight for Census block group i intersecting with the CWS or DWA, and X_i is the sociodemographic variable from Census block group i. For blocks with populated areas spanning multiple CWS or DWA boundaries, population was allocated based on an area-weighted apportionment of populated area within that block.

Water Quality

We used water quality data compiled by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment (OEHHA) for CalEnviroScreen4.0, a spatial screening tool to identify communities disproportionately burdened by pollution and social stressors.[30] To assess drinking water quality, OEHHA combined data from the State Water

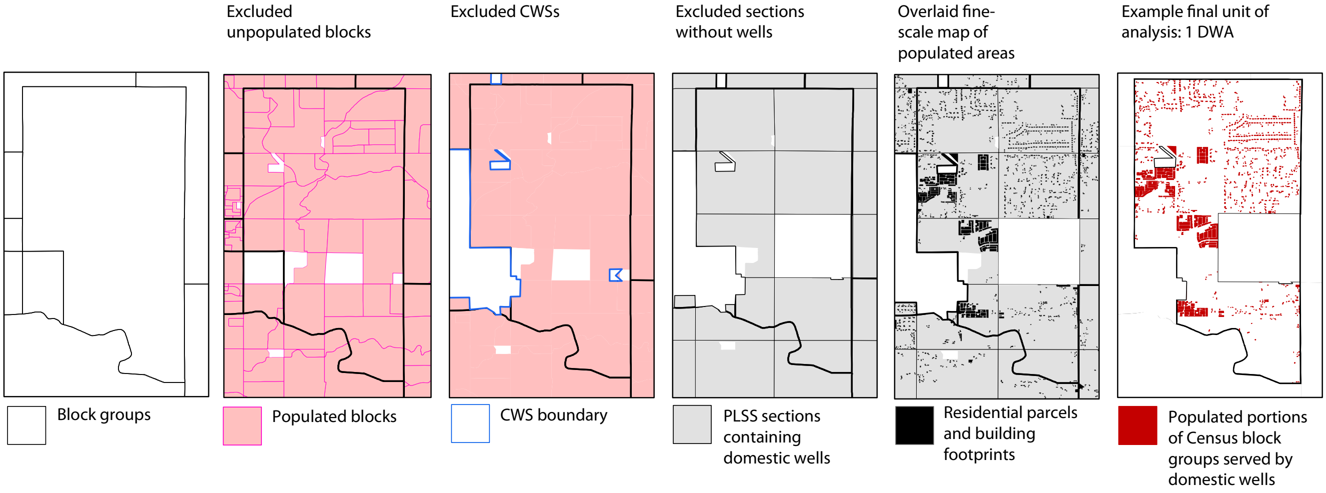

FIGURE 1— Schematic of Method for Identifying Domestic Well Areas (DWAs) in California

Note. CWS = community water system; PLSS = Public Land Survey System.

Resources Control Board's Water Quality Monitoring database over the most recent regulatory compliance cycle (2011–2019) to calculate a 9-year average for each water system. This enables comparisons between systems with different monitoring frequencies and across DWAs where sampling data are sparse. Contaminant values were time weighted and averaged across sources (including water purchased from wholesalers) for each CWS to represent estimated delivered water quality over the study period. Observations below the detection limit were replaced with zero.

DWA water quality estimates were also obtained from OEHHA, which time-weighted water quality samples from the State Water Resources Control Board's Groundwater Ambient Monitoring and Assessment program, and averaged these estimates for 2011 to 2019. Nondetects were treated similarly to those in the CWS data set. These concentrations were then averaged across all wells within a block group and assigned to DWAs by block group identifier.

Statistical Analysis

We calculated descriptive statistics for water quality and sociodemographic characteristics for DWAs and CWSs separately, stratified by the number of service connections (for CWSs) and region. We then used generalized additive models[31] to estimate associations between contaminant concentrations and sociodemographic characteristics across individual CWS and DWA observations. We ran models separately for DWAs and CWSs. Our outcome for each contaminant was a mean concentration of at least one half of the California maximum contaminant level (MCL), which was selected because MCLs are established considering financial and technical feasibility and are not always health protective.[32] We considered using the public health goal to derive our outcome measure, as this benchmark reflects concentrations that pose no significant health risk if consumed for a lifetime.[33] However, the public health goal was below the limit of detection for our contaminants and could not be reliably measured. Because Cr(VI) does not currently have an MCL in California, we used the rescinded MCL value (as of 2017), which is being revised.[34]

We also derived a continuous outcome of a cumulative water contaminant index:[35]

$$CCI_i = \sum_{i}^{n} C_i \Big/ \frac{1}{2} MCL_i \qquad (2)$$

where C_i is the 2011–2019 mean concentration, and MCL_i is the MCL for contaminant *i*. We conducted a sensitivity analysis in which we dichotomized outcome measures based on the detection limit rather than the one half MCL. MCLs, public health goals, and detection limits for all contaminants are shown in Table A (available as a supplement to the online version of this article at http://www.ajph.org).

Our models included the following independent variables: race/ethnicity (% non-Latinx White, % Latinx, and % non-Latinx people of color, which included all other races and ethnicities), and housing tenure (% renters). We lacked sufficient sample size to reliably derive effect estimates for more specific racial groups in our models while also controlling for region. We considered measures of linguistic isolation and poverty, but did not include them because of their collinearity with race/ethnicity and housing tenure (Pearson correlation coefficients = 0.43–0.87). We scaled continuous predictors by 10%. To account for underlying regional differences in groundwater arsenic and nitrate concentrations, we adjusted for region following definitions used in previous studies[36,37] (Figure B and Table B, available as supplements to the online version of this article at http://www.ajph.org). We omitted region from Cr(VI) models because it is a more localized contaminant. Models of CWSs controlled for water source (any groundwater vs exclusively surface water) and system size (15–199 vs ≥ 200 service connections) as an indicator of technical, managerial, and financial capacity.[6] Models of DWAs controlled for population density.

We adjusted for the DWA or CWS centroid coordinates to account for spatial autocorrelation by fitting smoothing parameters consisting of 2 or more piecewise polynomial functions (or splines) to model terms for latitude and longitude. We similarly included smoothing parameters for population density in DWA models to account for nonlinear relationships.[38] We used Moran's I to assess residuals for spatial autocorrelation.[39,40] All models reached full convergence, indicating an appropriate number of parameters. We examined model residuals for normality, diagnostic plots, and the K index to verify adequate basis dimensions. Estimates were stable, and fit was not improved (assessed with Akaike information criterion) by increasing the number of nodes.

For dichotomous outcomes, we specified a binomial distribution with logit link function to estimate prevalence ratios (PRs).[41] We used a Gaussian distribution with an identity link function for the cumulative contaminant index.[31] We conducted data processing in ArcGIS version 10.7.1 (ESRI, Redlands, CA). We conducted statistical analyses in R version 3.5.3 (R Foundation, Vienna, Austria).[42]

RESULTS

We estimate that 37 million Californians are served by 2851 active CWSs. Mean contaminant concentrations exceeded the MCL for at least 1 contaminant for 0.6% of the population served by CWSs (216 306 people). An estimated 1.3 million people are served by the 1914 DWAs in our analysis, and 12.1% of the population (157 367 people) use domestic wells in areas with mean groundwater concentrations exceeding the MCL for 1 or more contaminants (Table 1). We observed elevated arsenic and nitrate concentrations among CWSs and DWAs in the San Joaquin Valley, where more people were served water exceeding the MCL for these 2 contaminants than in any other region (Tables C and D, available as supplements to the online version of this article at http://www.ajph.org). The proportion of people of color and renters with water exceeding the MCLs were more often higher than the statewide average in the San Joaquin Valley, Imperial Valley and Mojave Desert, and Central Coast (Tables C and D).

Our multivariate analysis found that, among CWSs, a 10% increase in the Latinx population was associated with a 14%, 21%, and 31% increase in the likelihood of elevated arsenic, nitrate, and Cr(VI), respectively (PR = 1.14; 95% confidence interval [CI] = 1.06, 1.22 for arsenic; PR = 1.21; 95% CI = 1.12, 1.30 for nitrate; and PR = 1.31; 95% CI = 1.21, 1.43 for Cr[VI]); and a 0.11 unit increase in cumulative contaminant index (mean difference = 0.11; 95% CI = 0.08, 0.14; Table 2). A 10% increase in non-Latinx people of color was associated with a 31% increase in the likelihood of elevated nitrate (PR = 1.31; 95% CI = 1.15, 1.49), a 28% increase in the likelihood of elevated Cr(VI) (PR = 1.28; 95% CI = 1.12, 1.46), and a 0.07 unit increase in cumulative contaminant index (mean difference = 0.07; 95% CI = 0.02, 0.12); we saw little evidence of an association with arsenic (Table 2). There was no association between percentage of renters and likelihood of elevated contaminant concentrations among CWSs. Small system size and groundwater reliance were associated with elevated chemical concentrations. We observed statistically significant differences in cumulative contaminant index by region.

Among DWAs, a 10% increase in the Latinx population was associated with a 13%, 19%, and 23% increase in the likelihood of elevated nitrate, arsenic, and Cr(VI), respectively (PR = 1.13; 95% CI = 1.05, 1.21 for nitrate; PR = 1.19; 95% CI = 1.11, 1.28 for arsenic; and PR = 1.23; 95% CI = 1.13, 1.34 for Cr[VI]), and a 0.14-unit increase in cumulative contaminant index (mean difference = 0.14; 95% CI = 0.09, 0.19; Table 3). A 10% increase in non-Latinx people of color was associated with a 21% increase in the likelihood of elevated arsenic (PR = 1.21; 95% CI = 1.07, 1.37) and a 0.10 unit increase in cumulative contaminant index (mean difference = 0.10; 95% CI = 0.01, 0.19). A 10% increase in renters was associated with a 0.07-unit increase in cumulative contaminant index (mean difference = 0.07; 95% CI = 0.01, 0.12), while the associations with other contaminants were modest. Mean cumulative contaminant index was higher in the San Joaquin Valley.

Using the detection limit rather than the MCL as the cut-off for dichotomous outcomes resulted in effect estimates for the sociodemographic variables that were slightly attenuated for arsenic, stronger for Cr(VI), and mixed for nitrate (attenuated in CWS models and stronger in DWA models; Tables E and F, available as supplements to the online version of this article at http://www.ajph.org).

DISCUSSION

To our knowledge, this is the first environmental justice analysis of drinking water quality in California communities relying on either CWSs or domestic wells. We estimated that among the nearly 39 million people in California, 1.3 million rely on domestic wells, 37.1 million rely on CWSs, and 0.5 million rely on an unknown water source. Our estimate for domestic well use is consistent with previous research suggesting that 1.2 million people use a domestic well in California,[12] and 2 to 2.5 million Californians are served by a domestic well or state small water system rather than a CWS.[13,37] The range of these estimates is a likely attributable to different data sources, time frames, and methodologies. Our study may underestimate the number of domestic well users by 240,000 to 950 000 (assuming an average household size of 3 people and a range of 1 to 4 households served per well) because we assumed that domestic wells within CWS service areas were not used.

We found that populations reliant on domestic wells faced greater water quality concerns than those served by CWSs. Mean arsenic levels exceeding

TABLE 1— Mean Water Contaminant Concentrations (2011–2019) and Sociodemographics of Domestic Well Areas (DWAs) and Community Water Systems (CWSs) Stratified by System Size: California

	DWAs[a] (n = 1914)	Small CWSs[b] (n = 1773)	Medium CWSs[c] (n = 859)	Large CWSs[d] (n = 219)
Total population, no.	1 300 193	253 098	6 030 628	30 784 197
Population (%) ≥ MCL for 1 or more contaminant	157 367 (12.1)	22 307 (8.8)	157 622 (2.6)	36 377 (0.1)
Arsenic, μg/L				
Median (IQR)	1.1 (4.3)	< DL[e]	0.6 (2.1)	0.5 (1.4)
95th percentile	14.8	9.6	6.2	3.8
Population (%) ≥ MCL[f]	106 329 (8.2)	9 187 (3.6)	20 278 (0.33)	0 (0.0)
Nitrate as N, mg/L				
Median (IQR)	1.6 (3.6)	0.8 (2.4)	0.6 (2.2)	0.7 (2.0)
95th percentile	9.7	6.4	5.3	5.1
Population (%) ≥ MCL	56 230 (4.3)	3 774 (1.5)	1 607 (0.02)	0 (0.0)
Cr(VI), μg/L				
Median (IQR)	0.3 (2.3)	< DL	< DL	0.2 (1.1)
95th percentile	9.3	8.5	6.2	4.6
Population (%) ≥ MCL	30 080 (2.3)	10 538 (4.2)	135 737 (2.2)	36 377 (0.1)
% renters	30.3	34.9	42.3	45.8
% non-Latinx White	58.2	53.5	39.7	36.7
% Latinx	30.3	34.8	45.0	38.1
% non-Latinx Black	1.8	2.7	4.0	6.1
% non-Latinx Asian	5.3	5.1	8.0	15.6
% non-Latinx Native American	1.3	1.2	0.5	0.3
% non-Latinx other	3.0	2.7	2.8	3.3
% living in poverty	32.3	37.2	38.2	33.2
% linguistically isolated	36.4	41.2	41.2	58.0

Note. Cr(VI) = hexavalent chromium; DL = detection limit; IQR = interquartile range; MCL = maximum contaminant level.

[a] DWAs represent populated portions of Census block groups.
[b] CWSs with 15–199 service connections.
[c] CWSs with 200–9 999 service connections.
[d] CWSs with ≥ 10 000 service connections.
[e] < DL indicates below the DL. DLs for individual contaminants are as follows: arsenic = 2.0 μg/L; nitrate = 0.4 mg/L; Cr(VI) = 1.0 μg/L.
[f] Population (%) ≥ MCL reflects the number and percentage of people with average water concentrations exceeding the MCL. The MCL for arsenic is 10 μg/L. The MCL for nitrate as N is 10 mg/L. Cr(VI) does not currently have an MCL; we used the most recent MCL of 10 μg/L, which was rescinded in 2017 and is in the process of being revised.

the MCL affected a greater proportion of people who use domestic wells (8.2%) compared with those who use CWSs (3.9%; Table 1). Similarly, mean nitrate and Cr(VI) levels exceeded the MCL for 4.3% and 2.3% of the population in DWAs compared with 0.01% and 0.49% of the population served by CWSs, respectively. Although Bangia et al. did not incorporate domestic well locations into their analysis, their study on individual concentrations and MCL violations for 12 contaminants including arsenic, nitrate, and Cr(VI) similarly concluded that cumulative contaminant burdens were higher in areas outside CWSs.[37] Our finding of an association between small system size and elevated nitrate and arsenic concentrations is consistent with previous CWS studies in the San Joaquin Valley[6,9] and statewide.[37] Bangia et al. found that the most frequent MCL violations occur in small CWSs and the highest cumulative contaminant concentrations occur in the San Joaquin Valley.[37]

Previous empirical work suggests that natural, built, sociopolitical, and environmental factors mediate the actions of state, county, community,

TABLE 2— Generalized Additive Model Results Estimating the Association Between Sociodemographic Variables and 2011–2019 Mean Drinking Water Contaminant Concentrations Among Community Water Systems (CWSs): California

Dependent Variables	Arsenic ≥ 1/2 MCL (n = 2723), PR[a] (95%CI)	Nitrate ≥ 1/2 MCL (n = 2744), PR (95% CI)	Cr(VI) ≥ 1/2 MCL (n = 2628), PR (95% CI)	Cumulative Contaminant Index[b] (n = 2617), B[c] (95% CI)
% Latinx[d]	1.14 (1.06, 1.22)	1.21 (1.12, 1.30)	1.31 (1.21, 1.43)	0.11 (0.08, 0.14)
% non-Latinx people of color[d]	0.97 (0.85, 1.10)	1.31 (1.15, 1.49)	1.28 (1.12, 1.46)	0.07 (0.02, 0.12)
% renter[d]	0.94 (0.86, 1.02)	1.00 (0.91, 1.10)	0.97 (0.88, 1.06)	0.00 (–0.03, 0.03)
Groundwater source	9.31 (4.81, 18.05)	7.32 (3.71, 14.43)	4.77 (2.64, 8.52)	0.64 (0.51, 0.77)
15–199 service connections[e]	1.24 (0.92, 1.68)	1.43 (1.01, 2.03)	1.29 (0.91, 1.84)	0.15 (0.02, 0.27)
Central Coast[f]	1.30 (0.56, 3.02)	0.73 (0.32, 1.65)	. . .[g]	0.74 (0.38, 1.09)
Eastern Sierra	0.34 (0.12, 0.99)	. . .[h]	. . .[g]	0.31 (–0.11, 0.72)
Imperial Valley and Mojave Desert	0.23 (0.04, 1.15)	0.46 (0.11, 1.89)	. . .[g]	0.00 (–0.60, 0.60)
Northern California	2.28 (0.73, 7.12)	0.97 (0.31, 3.03)	. . .[g]	0.28 (–0.16. 0.72)
Northern Sierra	2.10 (0.90, 4.92)	0.56 (0.18, 1.78)	. . .[g]	0.65 (0.27, 1.04)
San Joaquin Valley	1.36 (0.66, 2.28)	1.26 (0.51, 3.12)	. . .[g]	1.10 (0.78, 1.42)
Southern California	0.61 (0.19, 1.93)	0.31 (0.10, 0.97)	. . .[g]	0.49 (0.01, 0.98)
AIC	1 676.65	1 294.82	1 253.61	9 006.18
Log likelihood	−809.73 (*df* = 28.60)	−625.4 (*df* = 22.00)	−604.07 (*df* = 22.74)	−4473.06 (*df* = 30.0)
Moran's I *P*	.78	.67	.8	.99

Note. AIC = Akaike information criterion; CI = confidence interval; MCL = maximum contaminant level. The California MCL for arsenic is 10 µg/L. The MCL for nitrate as N is 10 mg/L. Cr(VI) does not currently have an MCL; we used the most recent MCL of 10 µg/L, which was rescinded in 2017 and is in the process of being revised.

[a] PRs are prevalence ratios obtained by exponentiating the binomial model regression coefficients.

[b] The cumulative contaminant index (CCI) is the sum of individual mean contaminant concentrations (arsenic, nitrate, and Cr[VI]) divided by half of their respective MCLs. CCI ranged from 0.00 to 25.6 with a mean of 1.0 across all CWSs in the state.

[c] Estimates represent a mean difference and were obtained from Gaussian model parameter estimates.

[d] Continuous dependent variables were scaled by 10%.

[e] Comparison group is medium or large CWSs (≥ 200 service connections).

[f] Comparison group is the San Francisco Bay Area region.

[g] Region excluded from this model because Cr(VI) is a more localized contaminant than arsenic or nitrate.

[h] No CWSs in this region had the outcome.

and household actors in ways that result in drinking water disparities across race and class.[7] Consistent with this, water quality outcomes were significantly associated with race and ethnicity among both DWAs and CWSs in our analysis. Balazs et al. similarly found that, in the San Joaquin Valley, CWSs serving larger percentages of Latinx populations receive drinking water with higher nitrate levels, with a stronger association among small water systems (15–199 connections) than larger systems.[9] In addition, Balazs et al. reported that higher home ownership rates were associated with lower arsenic in the San Joaquin Valley.[6] In our analysis, we did not find associations between tenancy and arsenic concentrations in CWSs. However, we found a significant positive association between arsenic concentration and the proportion of Latinx residents in DWAs. Our results align with national county-level analyses showing greater arsenic MCL exceedances in CWSs reliant on groundwater, serving smaller populations, and serving Latinx populations,[43] and domestic wells in semi-urban Latinx communities.[44]

Our study expands upon previous research by considering multiple chemical contaminants, deriving a cumulative contaminant index, and incorporating domestic well populations through dasymetric mapping to produce refined population and sociodemographic estimates for both DWAs and CWSs.

Limitations of our study include the omission of state small water systems,

TABLE 3— Generalized Additive Model Results Estimating the Association Between Sociodemographic Variables and 2011–2019 Mean Groundwater Contaminant Levels Among Domestic Well Areas: California

Dependent Variables	Arsenic ≥ 1/2 MCL (n = 1782), PR[a] (95% CI)	Nitrate ≥ 1/2 MCL (n = 1917), PR (95% CI)	Cr(VI) ≥ 1/2 MCL (n = 1597), PR (95% CI)	Cumulative Contaminant Index[b] (n = 1587), B[c] (95% CI)
% Latinx[d]	1.13 (1.05, 1.21)	1.19 (1.11, 1.28)	1.23 (1.13, 1.34)	0.14 (0.09, 0.19)
% non-Latinx people of color[d]	1.21 (1.07, 1.37)	1.07 (0.93, 1.24)	1.11 (0.94, 1.30)	0.10 (0.01, 0.19)
% renter[d]	1.07 (0.99, 1.16)	1.06 (0.98, 1.16)	1.06 (0.95, 1.17)	0.07 (0.01, 0.12)
Central Coast[e]	0.96 (0.37, 2.48)	0.82 (0.35, 1.91)	. . .[f]	0.22 (–0.42, 0.86)
Eastern Sierra	0.83 (0.31, 2.25)	0.14 (0.01, 1.40)	. . .[f]	0.10 (–0.60, 0.80)
Imperial Valley and Mojave Desert	2.48 (0.34, 18.16)	1.13 (0.15, 8.56)	. . .[f]	0.04 (–1.21, 1.28)
Northern California	0.51 (0.18, 1.50)	0.41 (0.07, 2.28)	. . .[f]	−0.37 (–1.14, 0.40)
Northern Sierra	1.30 (0.56, 3.00)	1.11 (0.33, 3.77)	. . .[f]	0.41 (–0.22, 1.04)
San Joaquin Valley	1.91 (0.91, 3.99)	1.31 (0.55, 3.12)	. . .[f]	0.90 (0.37, 1.44)
Southern California	2.58 (0.61, 10.96)	0.17 (0.04, 0.30)	. . .[f]	0.04 (–0.90, 0.97)
AIC	1 700.72	1 466.24	1 028.27	6 339.41
Log-likelihood	−821.32 (*df* = 29.05)	−702.40 (*df* = 30.72)	−492.48 (*df* = 21.66)	−3140.16 (*df* = 29.55)
Moran's I *P*	.82	.63	.96	.54

Note. AIC = Akaike information criterion; CI = confidence interval; MCL = maximum contaminant level. The California MCL for arsenic is 10 μg/L. The MCL for nitrate as N is 10 mg/L. Cr(VI) does not currently have an MCL; we used the most recent MCL of 10 μg/L, which was rescinded in 2017 and is in the process of being revised.

[a] PRs are prevalence ratios obtained by exponentiating the binomial model regression coefficients.
[b] The cumulative contaminant index (CCI) is the sum of individual mean contaminant concentrations (arsenic, nitrate, and Cr[VI]) divided by half of their respective MCLs. CCI ranged from 0.0 to 112.6 with a mean of 1.8 across all DWAs in the state.
[c] Estimates represent a mean difference obtained from Gaussian model regression coefficients.
[d] Continuous dependent variables were scaled by 10%.
[e] Comparison group is the San Francisco Bay Area region.
[f] Region excluded from this model because Cr(VI) is a more localized contaminant than arsenic or nitrate.

which may have resulted in misclassifying domestic well areas that were actually state small systems. Because well completion reports had no information about current well use, our analysis may have overestimated the domestic well population by including inactive wells. The water quality data we used is a first-order approximation of household contaminant concentrations and assumes untreated groundwater samples are an accurate proxy for DWAs' water quality. Missing data contribute to uncertainty in our analysis and may have led to underestimates of contaminant concentrations, particularly in smaller CWSs (which are more likely than larger systems to violate monitoring requirements)[45] and in DWAs, where monitoring is not required. This may have led us to overestimate disparities across CWSs, as smaller systems have lower proportions of people of color and renters, and higher water-quality concerns (Table 1).

Our analysis may also have underestimated nitrate concentrations in DWAs because domestic wells tend to draw from shallow aquifers, while we relied on averaged samples from both shallow and deep aquifers. By contrast, Ransom et al.[46] modeled nitrates in shallow aquifers (< 500 meters) of California's Central Valley and considered depth to groundwater as a predictor, and the Groundwater Ambient Monitoring and Assessment program considered depth to groundwater in estimating water quality in their domestic well water study.[47] Future work is needed to improve contaminant concentration estimates at various aquifer depths for a broader set of chemicals.

Finally, we were not able to assess the extent to which our population relies on tap water for drinking as opposed to other sources, such as bottled water. National survey data indicate that Black and Latinx populations are less likely to consume tap water than Whites, which could attenuate the racial disparities in exposure to tap water contaminants suggested by our analysis. However, people may still be exposed to tap water contaminants through cooking and bathing. Additional research is also needed on the mechanisms through which the inequalities we observed are produced and can be remedied, as well as the unique vulnerabilities of unincorporated communities and unhoused individuals.

Our results suggest that a substantial number of Californians rely on domestic wells in areas of poor groundwater quality and that communities of color statewide are disproportionately affected by arsenic, nitrate, and Cr(VI) contamination of drinking water, both in CWSs and DWAs, with findings most pronounced in DWAs. Our study provides further evidence of unequal access to safe drinking water in California and, through our identification of DWAs, can support decision-makers in their efforts to (1) identify regions where more frequent water quality testing is needed to characterize the threats in domestic well communities; (2) elucidate solutions, including consolidation opportunities between DWAs with poor water quality and nearby CWSs with good water quality; and (3) safeguard drinking water supplies, prioritize funding, and track progress toward the human right to water.

ABOUT THE AUTHORS

Clare Pace and Rachel Morello-Frosch are with the Department of Environmental Science, Policy, and Management at the University of California, Berkeley. Carolina Balazs and Komal Bangia are with the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Oakland. Nicholas Depsky is with the Energy and Resources Group at the University of California, Berkeley. Adriana Renteria is with the Community Water Center, Visalia, CA. Lara J. Cushing is with the Department of Environmental Health Sciences, Fielding School of Public Health, University of California, Los Angeles.

CORRESPONDENCE

Correspondence should be sent to Rachel Morello-Frosch, Department of Environmental Science, Policy, and Management, University of California, Berkeley, 130 Mulford Hall, Berkeley, CA 94720-3114 (e-mail: rmf@berkeley.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

C. Pace participated in data curation, formal analysis, methodology, visualization, and writing the original draft. C. Balazs and L. J. Cushing participated in conceptualization, funding acquisition, methodology, and writing, reviewing, and editing. K. Bangia and N. Depsky participated in data curation and methodology. A. Renteria participated in funding acquisition, methodology, and visualization. R. Morello-Frosch participated in conceptualization, funding acquisition, methodology, supervision, and writing, reviewing, and editing.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

HUMAN PARTICIPATION PROTECTION

This study was exempt from institutional board review because no human participants were involved.

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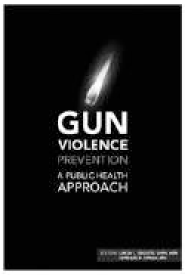

Heat Waves and Emergency Department Visits Among the Homeless, San Diego, 2012–2019

Lara Schwarz, MPH, Edward M. Castillo, PhD, MPH, Theodore C. Chan, MD, Jesse J. Brennan, MA, Emily S. Sbiroli, MD, Gabriel Carrasco-Escobar, MPH, Andrew Nguyen, BS, Rachel E. S. Clemesha, PhD, Alexander Gershunov, PhD, and Tarik Benmarhnia, PhD

See also Levy and Hernández, p. 48.

Objectives. To determine the effect of heat waves on emergency department (ED) visits for individuals experiencing homelessness and explore vulnerability factors.

Methods. We used a unique highly detailed data set on sociodemographics of ED visits in San Diego, California, 2012 to 2019. We applied a time-stratified case–crossover design to study the association between various heat wave definitions and ED visits. We compared associations with a similar population not experiencing homelessness using coarsened exact matching.

Results. Of the 24 688 individuals identified as experiencing homelessness who visited an ED, most were younger than 65 years (94%) and of non-Hispanic ethnicity (84%), and 14% indicated the need for a psychiatric consultation. Results indicated a positive association, with the strongest risk of ED visits during daytime (e.g., 99th percentile, 2 days) heat waves (odds ratio = 1.29; 95% confidence interval = 1.02, 1.64). Patients experiencing homelessness who were younger or elderly and who required a psychiatric consultation were particularly vulnerable to heat waves. Odds of ED visits were higher for individuals experiencing homelessness after matching to nonhomeless individuals based on age, gender, and race/ethnicity.

Conclusions. It is important to prioritize individuals experiencing homelessness in heat action plans and consider vulnerability factors to reduce their burden. (*Am J Public Health*. 2022;112(1):98–106. https://doi.org/10.2105/AJPH.2021.306557)

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Heat waves increase the risk of a wide range of health conditions, including cardiovascular- and respiratory-related outcomes.[1,2] Heat waves can trigger highly morbid physiological responses through various pathways, such as inflammation, heat cytotoxicity, ischemia, disseminated intravascular coagulation, and rhabdomyolysis, which can lead to significant end-organ damage and even death.[3] In California alone, heat waves have been shown to cause 11 000 excess hospitalizations in 20 years.[4] Targeted research can inform policies to protect vulnerable populations from the adverse health impacts of increasingly prevalent heat waves, as the frequency, intensity, and severity of heat waves have been increasing and are projected to increase further in California owing to climate change.[5]

Certain populations are commonly thought to be particularly vulnerable to the health effects of heat waves, including people who experience homelessness. In this context, we define increased vulnerability as having characteristics that modify the effect of heat waves on morbidity; this is measured by the differential health risks from heat waves across subgroups.[6] Although there are varying classifications of individuals experiencing homelessness, people are commonly considered homeless when they are without a physical shelter or are in physical shelters that do not meet basic standards of health and safety.[7] People that experience homelessness are considered to be among the most vulnerable to extreme weather impacts because of their exposure to the elements and high rates of preexisting health conditions, such as mental illness, as well as higher rates of smoking and drug and alcohol use.[8,9] It is estimated that approximately 30% of persons experiencing homelessness suffer from serious mental illness, and they have twice the odds of having unmet medical care needs as people living in homes.[10] Underresourcing of homelessness-related measures may further increase their vulnerability to harmful exposures.[9] Accessibility to air conditioning or a cool location during a heat wave is a strong indicator of heat-related health disparities.[11,12] As a population with no consistent access to reliable shelter, it is presumed that individuals experiencing homelessness should be a targeted population in heat action plans to mitigate the health burden they experience during heat waves.

The majority of evidence concerning heat impacts on the health of populations that experience homelessness has been based on qualitative findings or conceptual studies.[9,13–15] Research into the perceptions and experiences of these individuals and service providers indicates that heat waves adversely affect people experiencing homelessness. However, limited epidemiological studies exist to provide evidence of the association between heat waves and the health of persons experiencing homelessness. The factors that make them particularly vulnerable are still obscure.

According to a 2020 US Department of Housing and Urban Development assessment, California is particularly affected when it comes to homelessness. Partly because of the warmer climate[16] and the increasingly expensive housing market in California,[17] the state accounts for 51% of all unsheltered individuals in the entire country.[18] Not only is California the state with the highest number of people experiencing homelessness, but it also has one of the highest rates of homelessness at 41 people per 10 000.[18] The urban centers of San Diego City and County in California, in particular, had the fifth largest number of people experiencing homelessness in the United States in 2019.[18] Therefore, San Diego County is a fitting context to study vulnerability factors in this population.

We aimed to quantify the effects of heat waves on emergency department (ED) visits among patients experiencing homelessness. The results of this study can be used to provide evidence on the importance of prioritizing people who experience homelessness in heat warning systems and action plans and limit the harmful impacts of heat waves on vulnerable populations.

METHODS

We obtained ED utilization data from 2012 through 2019 for patients admitted to 1 of 2 hospitals in San Diego County in a single health system with a shared patient population and electronic medical record. One hospital is an urban academic teaching hospital (level 1 trauma center), whereas the second hospital is a suburban community hospital.

Patient and Exposure Data

We queried patient data from the electronic health record EPIC (Epic, Verona, WI) and included demographics and visit characteristics. Demographics included homelessness, age, ethnicity (Hispanic or not non-Hispanic), and race (American Indian/Alaska Native, Asian, Black/African American, Native Hawaiian/Pacific Islander, other race, or mixed race, White, or unknown). The homeless status of a patient was determined by registration staff or triage nurses upon arrival to the ED and based on their housing status at that time. Visit characteristics included whether the patient had a psychiatric consult (yes or no), time of day of ED arrival (day: 7:00 AM to 6:59 PM or night: 7:00 PM to 6:59 AM), and method of transportation to the hospital.

We used gridded observed data from the PRISM Climate Group of Oregon State University to derive daily maximum and minimum temperatures, averaged at the zip code level.[19] We restricted our analysis to the warm season, from May to September, consistent with previous literature studying heat and health in California.[1,4] As persons experiencing homelessness do not have a stable residence by definition, we used a weighted measure of point-in-time counts of individuals experiencing homelessness in San Diego County to characterize exposure by weighting daily maximum and minimum temperatures based on the number of individuals experiencing homelessness in that zip code.[20] Point-in-time counts are an annual count of people experiencing homelessness on a single night in January collected by the US Department of Housing and Urban Development.[18,20] To capture the potential range in effects based on heat wave measurements, we considered multiple heat wave definitions, including where the weighted temperature exceeded the 99th, 97.5th, and 95th percentiles of the total temperature distribution of the study period for 1 or 2 days. For 1-day events, we defined any daily temperature exceeding the percentile of interest as a heat wave day, whereas we defined 2-day heat wave temperature as exceeding the threshold for 2 consecutive days. When applying these definitions to both maximum and minimum (to capture nighttime heat waves) temperatures, we considered

12 definitions for analysis. Nighttime heat waves defined using minimum temperature thresholds can also be associated with hot daytime temperatures and are commonly expressed with increased humidity in the California climate.[5]

Statistical Analysis

We categorized age as 18 to 44 years, 45 to 64 years, and 65 years or older, as the elderly (older than 65 years) have been shown particularly vulnerable to heat.[21] We categorized method of transportation as ambulance transportation (paramedic unit, basic life support, critical care transportation, private ambulance), personal transportation (automobile, public transportation, taxi, walk-in), and other (helicopter, military, police custody, special transportation, unknown). We conducted descriptive analyses of patient and visit characteristics.

We used a time-stratified case–crossover design to study the association between each heat wave definition and ED visit in the population experiencing homelessness. The methodology resembles the design and analysis of a case–control study, but we identified control days for each case in the study population. We selected control days based on the same day of the week of the ED visit in the same month and year that the case occurred, and we compared exposure to a heat wave for these case and control days. Each case day had 3 to 4 control days. The benefit of this methodology is that, as we treated each ED visit as its own control, all potential time-fixed confounding is adjusted for by design. We employed a conditional logistic regression model to study the association between heat waves and ED visits for each heat wave measure. We stratified the study population by age group, race, ethnicity, psychiatric consultation, means of arrival, and time of day of the ED visit. We ran independent regressions for each subgroup and heat wave definition. We applied the Cochran Q test to understand heterogeneity between subgroups.

We used coarsened exact matching to match the distribution of ED visits among individuals experiencing homelessness to the nonhomeless patients based on age (18–24, 25–34, 35–44, 45–54, 55–64, or ≥ 65 years), gender (female, male, or unknown), and race/ethnicity (categories described in Patient and Exposure Data). We then conducted stratified analyses in the matched data set, comparing the ED visits of individuals experiencing homelessness with those of nonhomeless individuals.

Sensitivity Analysis

As some patients visited the ED multiple times, we applied a sensitivity analysis by restricting the study to patients experiencing homelessness who visited the ED only 1 time in the study period. This was to ensure that any results were not driven by multiple ED visits from the same individuals. We also conducted a sensitivity analysis with heat waves based on apparent temperature, using estimates accounting for relative humidity, consistent with previous work.[22]

RESULTS

A total of 24 688 ED visits were by patients who were identified as homeless in the 2 hospitals during May to September from 2012 to 2019 out of 242 262 total visits over the study period. Among ED visits by individuals experiencing homelessness, the majority (94%) were younger than 65 years, of non-Hispanic ethnicity (84%), and White (60%; Table 1). Of the 12 heat wave definitions considered in the analysis, the number of events that exceeded the threshold ranged from 4 (99th percentile, 2 days, maximum temperature) to 62 (95th percentile, 1 day, minimum temperature). The temperature thresholds for heat wave events ranged from 20.4°C for the minimum temperature in the least stringent definition to 34.5°C for the maximum temperature in the most stringent definition (Table 2). Heat waves were generally well distributed across the study years, with the majority of events occurring in the later months (Figure A, available as a supplement to the online version of this article at http://www.ajph.org). The thresholds we used for heat wave definitions varied spatially across San Diego, with higher temperature thresholds in the inland region and lower temperature thresholds in the coastal areas (Figure B, available as a supplement to the online version of this article at http://www.ajph.org). The daily mean number of ED visits was generally higher on heat wave days, with an average of 22.83 cases on heat wave days and an average of 20.71 visits on non–heat wave days (Table 2).

We found a consistent positive signal between heat waves and the risk of ED visits of people experiencing homelessness for the majority of heat wave definitions considered (Figure A). The strongest precise signal detected was 2-day heat waves defined at the 99th percentile using maximum temperature, which increased odds of an ED visit by 1.29 (95% confidence interval [CI] = 1.02, 1.64). Results also indicated effects for heat wave definitions based on minimum temperature, although

TABLE 1— Description of Patients Experiencing Homelessness Who Visited an Emergency Department: San Diego, CA, May–September 2012–2019

Characteristic	No. (%)
Age, y	
18–44	9 666 (39.15)
45–64	13 437 (54.43)
≥ 65	1 585 (6.42)
Ethnicity	
Hispanic	3 448 (13.97)
Non-Hispanic	20 729 (83.96)
Unknown	511 (2.07)
Race	
American Indian/Alaska Native	68 (0.28)
Asian	117 (0.47)
Black/African American	4 829 (19.56)
Native Hawaiian/Pacific Islander	35 (0.14)
Other race/mixed race	4 298 (17.41)
Unknown	539 (2.18)
White	14 802 (59.96)
Psychiatric consultation	
No	21 202 (85.88)
Yes	3 486 (14.12)
Time of admission	
Day (7:00 AM to 6:59 PM)	15 381 (62.30)
Night (7:00 PM to 6:59 AM)	9 307 (37.70)
Method of transportation to ED	
Emergency	12 703 (51.46)
Personal	10 436 (42.28)
Other	1 545 (6.26)

Note. ED = emergency department. The population size was n = 24 688.

we no longer observed this when considering heat waves based on apparent temperature (Figure C, available as a supplement to the online version of this article at http://www.ajph.org). Generally, odds of an ED visit increased with longer heat waves at more extreme temperature thresholds, particularly on the second day of 2-day heat waves (Figure 1).

We also identified vulnerability characteristics among patients experiencing homelessness. In the stratification by age group, we observed a stronger effect in the youngest population (aged 18–44 years) and the oldest population (aged ≥ 65 years) than in the middle-aged group (aged 45–65 years) (Figure 2; Table C, available as a supplement to the online version of this article at http://www.ajph.org). There was also a consistently stronger effect for patients requiring a psychiatric consultation than for those who did not (Figure 2). When we considered the method of transportation to the ED, we found that individuals who arrived by personal transportation appeared to be more affected by daytime heat wave events, whereas those arriving with an emergency vehicle appeared to be more affected by nighttime heat waves (Figure D; Table D, available as a supplement to the online version of this article at http://www.ajph.org). When stratifying the population by time of admission to the hospital, daytime ED visits were slightly higher and had more precise effects (Figure C).

Stratification by race/ethnicity led to imprecise estimates attributable to small sample sizes, and we could not draw any differences from these results (Table A, available as a supplement to the online version of this article at http://www.ajph.org). When considering ethnicity, we observed an effect for both Hispanic and non-Hispanic groups, although precision increased for non-Hispanic patients (Figure 2). The heat wave definition that drives the greatest health burden for Hispanic patients is the 97.5th percentile threshold for 2 consecutive days using maximum temperature, which increased the odds of an ED visit by 1.32 (95% CI = 0.95, 1.83), although the effect is imprecise. When stratifying by time of admission and ethnicity, estimates are even more imprecise (Figure E, available as a supplement to the online version of this article at http://www.ajph.org).

Overall, persons experiencing homelessness were more vulnerable to heat waves than were nonhomeless persons (Figure F; Table B, available as a supplement to the online version of this article at http://www.ajph.org). The results of the sensitivity analysis restricting patients that have visited the ED only once in San Diego County are consistent with the other findings and show that multiple ED visits by the same individual are not driving the observed effects (Figure G available as a supplement to the online version of this article at

TABLE 2— Environmental Description and Number of Daily Emergency Department Visits by Heat Wave Definition: San Diego, CA, May–September 2012–2019

Heat Wave Definition (HWD)	Temp Metric	Percentile (Temperature, °C)	Duration, Days	No. Days (%)	Mean Cases Non-HW (SD)	Mean Cases During HW[a] (SD)
HWD1	Maximum	95 (31.52)	1	61 (4.98)	20.69 (6.02)	21.85 (6.64)
HWD2	Maximum	95 (31.52)	2	34 (2.78)	20.68 (6.03)	22.71 (6.66)
HWD3	Maximum	97.5 (32.92)	1	31 (2.53)	20.74 (6.04)	20.84 (6.74)
HWD4	Maximum	97.5 (32.92)	2	16 (1.31)	20.73 (6.05)	22.25 (6.49)
HWD5	Maximum	99 (34.54)	1	13 (1.06)	20.73 (6.05)	22.08 (6.96)
HWD6	Maximum	99 (34.54)	2	4 (0.33)	20.74 (6.04)	23.5 (11.27)
HWD7	Minimum	95 (20.42)	1	62 (5.07)	20.67 (6.05)	22.05 (6.17)
HWD8	Minimum	95 (20.42)	2	39 (3.19)	20.71 (6.04)	22.92 (6.61)
HWD9	Minimum	97.5 (20.99)	1	30 (2.45)	20.70 (6.03)	22.53 (7.02)
HWD10	Minimum	97.5 (20.99)	2	14 (1.14)	20.69 (6.03)	25.21 (6.80)
HWD11	Minimum	99 (21.63)	1	13 (1.06)	20.70 (6.04)	24.77 (6.46)
HWD12	Minimum	99 (21.63)	2	7 (0.57)	20.73 (6.05)	23.29 (7.41)

Note. The population size was n = 24 688.

[a] On the second day for 2-day heat waves.

http://www.ajph.org). The Cochran Q heterogeneity test indicated a difference between subgroups at the 10% significance level for some heat wave definitions, although this was not consistent across all comparisons (Table B).

DISCUSSION

Capitalizing on a unique data set with detailed information on the sociodemographics of ED visits, this study provides evidence that persons who are experiencing homelessness have increased odds of visiting an ED during a heat wave event compared with the nonhomeless population (Figure F). Although individuals experiencing homelessness have been targeted by heat action plans aimed at limiting the health effects of heat waves,[14,23] these results provide the first epidemiological evidence, to our knowledge, to substantiate this effort and evaluate which characteristics contribute to this presumed vulnerability. By using a range of metrics to define heat wave events and patient-level demographic information, this study denotes that certain subgroups are particularly at risk and illustrates that the association can vary by metric used to define heat wave events.

Various early warning systems and heat action plans have considered populations that experience homelessness to be a particularly vulnerable group.[23] For example, action plans in Phoenix, Arizona, provided cooling stations and distributed water in areas where people who were experiencing homelessness congregated and included a psychiatrist on outreach teams for triaging mental health needs.[23] In a qualitative study on Montreal, Canada's heat action plan evaluating the perceptions of vulnerable populations, some of whom were individuals experiencing homelessness, participants indicated that messaging to lessen the negative impacts of heat waves was not effective. For example, some of the recommendations of the heat action plan included spending time in a cooled public area; however, some participants mentioned being asked to leave by guards when seeking refuge in these areas.[14] Although populations experiencing homelessness are recognized as a priority in many early warning system or heat action plans, the most appropriate actions to protect these individuals may be more challenging to identify than the measures indicated for other high-risk groups.

These results are valuable for understanding the implications of an increasingly prevalent exposure for the health of people experiencing homelessness and can be used to inform targeted actions to provide appropriate resources to this highly vulnerable population. Using thresholds based on past climatic data to define heat waves is useful in providing an evidence-based structure for activating interventions to protect vulnerable populations during heat waves and can be effective in decreasing heat-related illnesses.[24] The

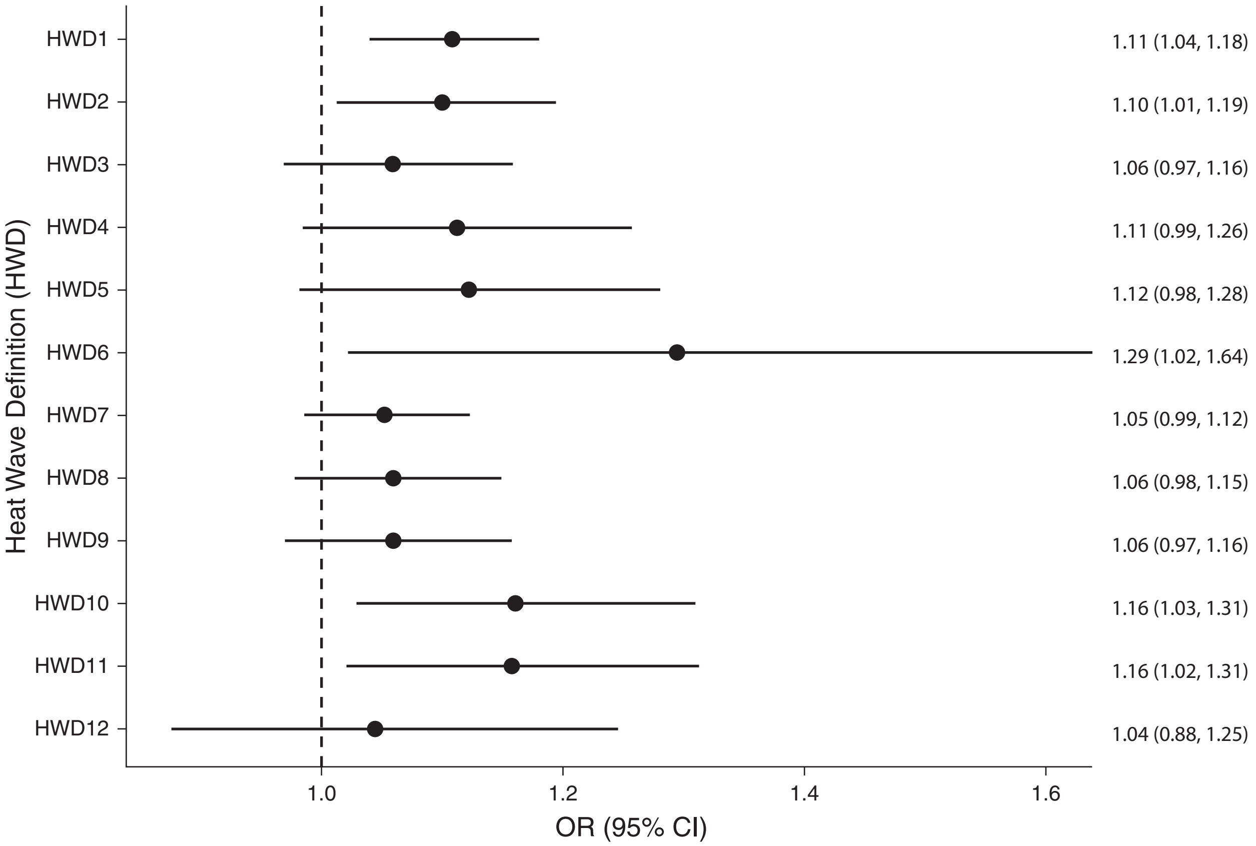

FIGURE 1— Odds Ratios (ORs) and 95% Confidence Intervals (CIs) of Heat Wave Impacts on Emergency Department Visits Among Patients Experiencing Homelessness: San Diego, CA, May–September 2012–2019

evidence can also be useful for health care systems to better identify heat-related stress and be prepared to care for this vulnerable population during heat waves.

Our result that the younger adult age group had increased vulnerability differs from the existing literature on heat waves and morbidity in the general population. A literature review on heat waves and morbidity indicates that children and the elderly are at increased risk for morbidity during heat wave events,[25] but no study to our knowledge has identified the adult population younger than 45 years to be a vulnerable group. The increased vulnerability of this group may be driven by the higher proportion of persons in that age group (23.8%) that required a psychiatric consultation, as compared with 13.6% and 13.4% in the middle-aged and elderly age groups, respectively. A meta-analysis on heat-related deaths showed that preexisting psychiatric illness triples the risk of heat wave–related mortality; this is thought to be related to the impaired ability of these individuals to recognize symptoms of heat exposure, seek access to a cool space, and rehydrate during a heat wave.[26] The higher vulnerability in the elderly population is consistent with previous work on heat-related impacts[21,27]; weakened physiological responses, higher prevalence of underlying health risks, and vulnerability caused by social isolation are risk factors that are associated with older age.[27]

The results indicating increased vulnerability for patients who required a psychiatric consultation is consistent with previous literature. A systematic review on the health effects of high ambient temperatures and heat waves on mental health found an increased risk of mental health–related ED visits during heat waves.[28] The review also indicated that the risk of mortality attributable to substance and alcohol misuse increased during a heat wave.[28] These results indicate that targeting persons who are experiencing homelessness and have psychiatric conditions during extreme heat may be an effective strategy; including a psychiatrist on outreach teams, as has been done in Phoenix, Arizona, could be very beneficial to this specific population.[23]

A difference in vulnerability by ethnicity is not apparent, consistent with the

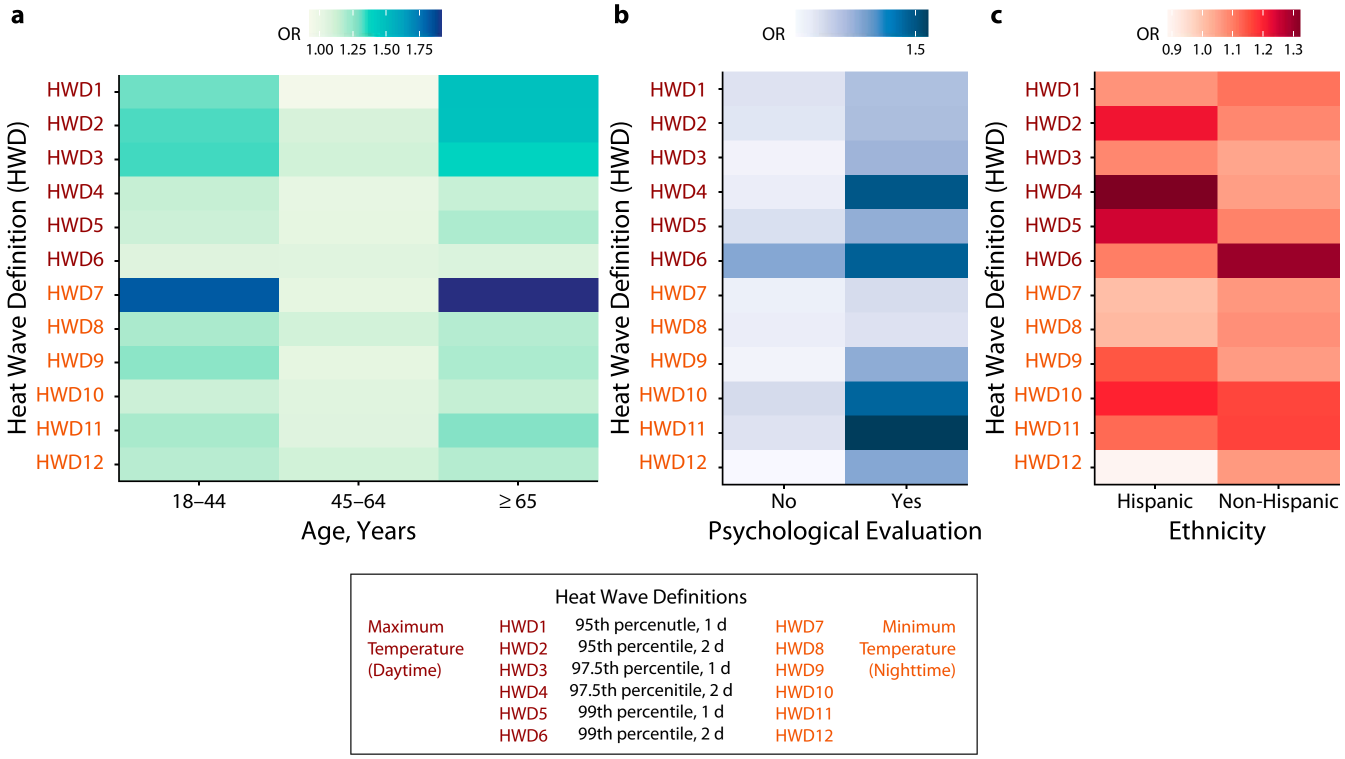

FIGURE 2— Odds Ratios (ORs) of Heat Wave Impacts on Emergency Department Visits Among Patients Experiencing Homelessness by (a) Age Group, (b) Encounter With a Psychiatric Consultation, and (c) Hispanic Ethnicity: San Diego, CA, May–September 2012–2019

existing literature on ethnic disparities in heat wave impacts in the general population. For example, Guirguis et al. did not find a greater impact of temperature on hospitalizations for Hispanic individuals, despite this population having lower access to air conditioning than do non-Hispanic White residents in San Diego County.[11] The effects we observed for nighttime heat waves throughout the main and stratified analyses are noteworthy. A study assessing the effect of heat waves on individual exposure by using wearable sensors indicated that nighttime heat waves are associated with increased heat inequality, as income, employment type, and housing type were found to be strongly associated with heat exposure during the night.[29] Also, nighttime heat waves are associated with increased humidity,[5] which may be a driver of this increased effect. Interestingly, we no longer observed the effect when we considered nighttime heat waves based on apparent temperature, indicating the need to further explore the role of humidity in driving the health impacts of nighttime heat waves.

This study is one of the first to highlight the vulnerability of persons experiencing homelessness to the health effects of heat waves and explore underlying factors that contribute to this association. We exploited a data set that has detailed information about ED visits to understand vulnerability factors in a county with one of the highest rates of individuals experiencing homelessness in the United States.[18] Although we were able to detect heterogeneous effects across some subgroups (Table B), other heterogeneity test results did not show differences between subgroups. This is mostly because of the relatively small sample size of our study, and future studies may replicate such analyses in different contexts and larger samples. This first assessment is critical to understanding the specific vulnerability of persons experiencing homelessness to increasingly frequent and intense heat wave events.[5]

Limitations

This study has some limitations that are important to acknowledge. First, we did not consider the role of humidity in our main analysis, which may play an important role in the experience and effects of heat; nevertheless, a sensitivity analysis considering apparent temperature showed similar results for daytime heat waves. We focused on ED visits in 1 hospital system. The effect of heat waves on this population may also drive impacts in other hospital systems and health measures. Although these findings are not generalizable to the entire population of people experiencing homelessness in San Diego, we believe these findings can serve as a first demonstration of the vulnerability of this group and will pave the way for future work on this topic. Also, homeless status of the patient is determined upon arrival to the ED; this categorization may only include populations that have no access to housing and exclude populations that have inadequate or insecure housing. Lastly, the point-in-time counts of individuals experiencing homelessness in San Diego we used for the exposure assessment are determined annually on 1 night in January[20]; this may vary from what would be observed in the summer months. However, as San Diego has a moderate year-round climate, the difference may not be as important as it would be in other regions.

Public Health Implications

There are many other important areas for future work on the topic of individuals experiencing homelessness and heat-related health impacts. First, the susceptibility of persons who are homeless in San Diego County may differ greatly from that of other cities; therefore, it would be important to study this question across different contexts. Additionally, there are many ways to define homelessness, and examining different measures of homelessness or housing exclusion would be important in future work.[30] Also, although we were unable to study differential susceptibility of this homeless population by race because of the limited sample size, we hope to be able to explore potential racial disparities in future work; minority populations are hugely overrepresented in the homeless population compared with the general population of San Diego.[20] However, this assessment is important to demonstrate the first evidence of the susceptibility of this population and can be expanded to explore differential vulnerability across populations and contexts.

Homelessness is rapidly becoming a major social challenge in the United States. Structural inequalities,[31] housing crises,[32] high rental costs,[33] and natural disasters[34] have all contributed to the increasing number of persons experiencing homelessness in recent years.[18] The nation has seen increases in homelessness for the past 3 years, particularly during the COVID-19 pandemic; the number of people who became homeless for the first time more than doubled in San Diego County in 2020 compared with 2019.[18,20] As the threat of increasingly frequent and more intense heat waves continues to rise in the United States,[34] particularly in California,[5] understanding and prioritizing the needs of this rapidly growing vulnerable population will be a critical action in developing and deploying effective mitigation strategies. As the first study, to our knowledge, to quantify the effect of heat waves on the health burden of persons experiencing homelessness by using reproducible heat wave definitions, we hope to pave the way for additional studies to provide evidence on how to best protect this population in the context of climate and social change. AJPH

ABOUT THE AUTHORS

Lara Schwarz and Gabriel Carrasco-Escobar are with the Herbert Wertheim School of Public Health and Longevity Science, University of California, San Diego, La Jolla. Edward M. Castillo, Theodore C. Chan, Jesse J. Brennan, and Emily S. Sbiroli are with the Department of Emergency Medicine, University of California, San Diego. Andrew Nguyen, Rachel E. S. Clemesha, Alexander Gershunov, and Tarik Benmarhnia are with Scripps Institution of Oceanography, University of California, San Diego.

CORRESPONDENCE

Correspondence should be sent to Lara Schwarz, MPH, 8880 Biological Grade, Room 165, University of California, San Diego, La Jolla, CA 92037 (e-mail: lnschwar@health.ucsd.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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L. Schwarz, E. M. Castillo, T. C. Chan, J. J. Brennan, E. S. Sbiroli, and T. Benmarhnia led the project's conceptual development. L. Schwarz, A. Nguyen, and R. E. S. Clemesha analyzed the data. G. Carrasco-Escobar and A. Nguyen assisted in results presentation and figure production. A. Gershunov supported the results interpretation and reviewed the article. All authors edited and approved the final version.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

No protocol approval was necessary because data analysis in this study was de-identified.

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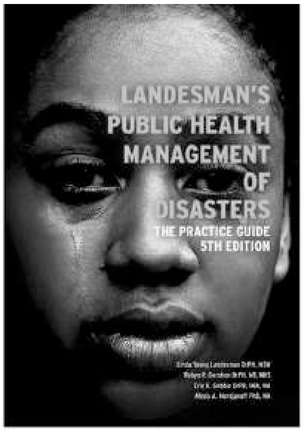

Cold Weather and Cardiac Arrest in 4 Seasons: Helsinki, Finland, 1997–2018

Niilo R. I. Ryti, MD, PhD, Jouni Nurmi, MD, PhD, Ari Salo, MD, Harri Antikainen, PhD, Markku Kuisma, MD, PhD, and Jouni J. K. Jaakkola, MD, PhD

See also Levy and Hernández, p. 48.

Objectives. To test the a priori hypothesis that out-of-hospital cardiac arrest (OHCA) is associated with cold weather during all seasons, not only during the winter.

Methods. We applied a case–crossover design to all cases of nontraumatic OHCA in Helsinki, Finland, over 22 years: 1997 to 2018. We statistically defined cold weather for each case and season, and applied conditional logistic regression with 2 complementary models a priori according to the season of death.

Results. There was an association between cold weather and OHCA during all seasons, not only during the winter. Each additional cold day increased the odds of OHCA by 7% (95% confidence interval [CI] = 4%, 10%), with similar strength of association during the autumn (6%; 95% CI = 0%, 12%), winter (6%; 95% CI = 1%, 12%), spring (8%; 95% CI = 2%, 14%), and summer (7%; 95% CI = 0%, 15%).

Conclusions. Cold weather, defined according to season, increased the odds of OHCA during all seasons in similar quantity.

Public Health Implications. Early warning systems and cold weather plans focus implicitly on the winter season. This may lead to incomplete measures in reducing excess mortality related to cold weather. (*Am J Public Health*. 2022;112(1):107–115. https://doi.org/10.2105/AJPH.2021.306549)

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Substantial epidemiological evidence shows that mortality and morbidity from various causes is associated with cold weather.[1,2] According to one study in 383 locations around the world, 7.3% of total mortality was attributed to temperatures below the local optimum.[1] According to another study, the majority of the world's population lives in areas that could benefit from cold weather plans.[3] Organizations such as Public Health England and the National Institute for Health and Care Excellence have for years produced guidelines aimed at reducing weather-related excess winter mortality.[4] Patients with cardiovascular diseases are considered particularly vulnerable,[4–7] and consistent epidemiological evidence shows that cold weather increases the risk of acute myocardial infarction,[8] out-of-hospital cardiac arrest (OHCA),[9–14] and sudden cardiac death.[15,16]

The current early warning systems and cold weather plans focus implicitly on the winter season,[4,17] but what if unseasonably cold weather induces adverse health effects during the warm season too? Recent epidemiological evidence indicates that most of the temperature-related mortality burden is attributed to moderately low temperatures.[1] This can be explained by the high proportion of moderately cold days in a year. Some studies report similar findings for OHCA.[18] These studies do not elaborate on the seasonal context in which the temperatures occur. Another way of looking at the same phenomenon is to define cold weather in the context of the seasonal frequency distribution of daily temperatures, which produces indicators of unusually cold weather for the time and place.[15,16] The concept of the summer cold spell may seem counterintuitive, but meaningful physiological reactions take place at moderately low temperatures.[19] Consistent experimental evidence shows cardiovascular aggravation during short-term exposure to air that is just a few degrees below thermoneutrality (23°C to 26°C air for a resting, naked human).[19–24] Evidence from studies investigating acclimatization indicate that cardiovascular responses to moderate cold exposures may be even stronger during the warm season, when the preceding acclimatization to heat is disrupted.[25–30] Thermal exposures in humans are largely determined by clothing, microclimate, and behavioral adaptation, which, together with external factors such as indoor heating, are not tuned toward cold weather in the warm season.[25,31]

We hypothesized that there is an association between cold weather and OHCA during all seasons, not only during the winter. Demonstrating this could have implications beyond OHCA prevention by bringing attention to the fact that if early warning systems and cold weather plans are confined to the winter season, the problem is addressed only partially.

METHODS

We conducted a population-based epidemiological study, applying a case–crossover design on a prospective OHCA registry, to assess the relation between season-specific cold weather and OHCA in Helsinki, Finland, over 22 years: 1997 to 2018. We applied STROBE guidelines[32] in reporting the results.

Study Population

All consecutive cases of OHCA from the Helsinki Cardiac Arrest Registry who were aged 18 years or older and whose primary cause of cardiac arrest was medical according to the 2015 update of the Utstein Resuscitation Registry Templates for OHCA[33] were included in this study. We limited the study population to adults under the assumption of heterogeneity of OHCA etiology in the neonates, children, and adolescents. The Helsinki Cardiac Arrest Registry has been compiled following a prospective study protocol, and it includes all cases of witnessed and nonwitnessed sudden OHCAs, regardless of whether resuscitation was attempted, in the city of Helsinki, Finland, from 1997 onward.[34,35] Each entry to the registry is made by a specialist physician or emergency medical services field supervisor. Quality control is managed by a specialist physician on a daily basis. In Finland, practically all cases of both witnessed and nonwitnessed cardiac arrests are reported to the emergency dispatch 112, and, therefore, selection bias is minimal. This provides a good opportunity to cover the entire breadth of OHCA cases in the general population.

For the purposes of this study, we revalidated the medical versus nonmedical causes of OHCA by cross-examining data in various data fields, including the event descriptions and findings of coronary angiography and autopsy, where available. The division between medical and nonmedical causes of OHCA can be considered robust. Cases were excluded if the most likely primary cause of OHCA was trauma, drug overdose, drowning, electrocution, asphyxia, or not recorded.[33] We also excluded cases that had missing data on the location of the cardiac arrest (n = 8).

Exposure Assessment

We obtained a set of 10-kilometer-by-10-kilometer grids of daily minimum, mean, and maximum temperatures in Finland from 1961 to 2018 from the Finnish Meteorological Institute. The grids had been produced from daily weather station data by using a Kriging interpolation method, including altitude and the percentage of lake or sea as auxiliary variables.[36] We organized the weather data into a geographic information system (GIS) database, and we used GIS-based functions to extract continuous time-series of daily temperatures at each of the 8 rescue stations in Helsinki over the study years. We defined for each case a 7-day hazard period, including the day of OHCA and 6 preceding days.[15,16] We defined for each case 21 reference periods consisting of the same calendar days of the other study years. Each case of OHCA took place in the service area of a specific rescue station, and we extracted the daily temperature values for the dates of the hazard period and 21 reference periods from the continuous time-series of the pertinent rescue station. Using these daily temperature values, we calculated frequency distributions of daily temperatures for each case. Cold day was defined as a day with daily mean temperature below the fifth percentile of the individual frequency distribution. This method identifies days that are unusually cold in a given time and place.[15,16] We selected cold weather events of predefined durations a priori as predictors in the statistical models: (1) 1 or more, 2 or more, 3 or more, or 4 or more consecutive cold days during the hazard period, with each minimum duration serving as a dichotomic predictor in a separate model, and (2) the absolute number of cold days during the hazard period as a continuous variable, with values from 0 to 7, without the requirement for consecutive order.

Statistical Analyses

The statistical inference was based on a comparison of the occurrence of predefined cold weather during the hazard and reference periods. We estimated odds ratios (ORs) as the measure of effect, including 95% confidence intervals (95% CIs), by conditional logistic regression with PROC PHREG in SAS version 9.4 (SAS Institute, Cary, NC), applying the discrete logistic model and forming a stratum for each case identification number. We formed an indicator variable consisting of 5- to 6-year intervals over the study period to adjust for long time trends in the occurrence of cold spells. Season, month, day of the week, and holidays were controlled by design. The design also adjusts for time-invariable factors such as individual characteristics of the cases or changes in them over time.[16] The decision of not including air pollutants in the models was made a priori, because air pollutants are treated as intermediate variables in the pathway from cold weather to OHCA.[37] If part of the effects of cold weather was mediated by increased air pollution levels, adjustment for air pollution would lead to an underestimation of the overall effects of cold weather.

We conducted stratified analyses according to the season of OHCA. We used calendar time to define the 4 seasons (autumn: September to November; winter: December to February; spring: March to May; summer: June to August). We also conducted stratified analyses according to an increasing number of consecutive cold days during the hazard period (≥ 1, ≥ 2, ≥ 3, ≥ 4). We performed subgroup analyses by age (18–64, ≥ 65 years) and sex.

We performed several sensitivity analyses to assess the robustness of results. First, we repeated the main analyses with minimum and maximum temperatures. Second, we extended the study period of the weather data and, consequently, the length of the individual frequency distributions of daily temperatures from 22 years to 38 years and 57 years. Third, we excluded the time trend adjustment from the models. Fourth, we divided the data into four 5- to 6-year periods, in which the reference periods for each case were limited to the same years of the respective period (i.e., a case in year 2015 would have reference periods from the years 2014, 2016, 2017, and 2018). Fifth, we repeated the main analyses for all adult cases, irrespective of the etiology of OHCA. Sixth, we excluded subsequent OHCAs in individuals with multiple OHCAs during the study period, and repeated the main analyses with the first OHCAs. Seventh, we excluded from the analyses the individuals with more than 1 OHCA during the study period.

We conducted all analyses with SAS version 9.4.

RESULTS

A total of 5685 adult cases of nontraumatic OHCA occurred in the city of Helsinki during the 22-year study period. After we excluded the 8 cases with missing location information, 5677 cases were included in the study. A flow diagram of the screening and selection process of eligible cases is provided in Figure A (available as a supplement to the online version of this article at http://www.ajph.org). Geospatial distribution of the cases in the 8 rescue station service areas is presented in Figure B (available as a supplement to the online version of this article at http://www.ajph.org).

Table 1 shows characteristics of the study population, with no marked differences in the incidence of OHCA by season or year. The 5th-percentile thresholds for seasonal cold days ranged from 11.6°C in summer to −15.9°C in winter. Table 2 shows descriptive statistics of daily temperatures in Helsinki during the study period of 1997 to 2018. These data were based on the time-series at the centrally located Käpylä rescue station. There were no major differences in temperature statistics between the other rescue stations.

Conditional logistic regression showed positive associations between cold weather and OHCA. Compared with weeks without cold days, the odds of OHCA increased 15% (95% CI = 7%, 24%) if there was at least 1 cold day during the hazard period. Each additional cold day during the hazard period increased the odds by 7% (95% CI = 4%, 10%), with similar strength of association during autumn (OR = 1.06; 95% CI = 1.00, 1.12), winter (OR = 1.06; 95% CI = 1.01, 1.12), spring (OR = 1.08; 95% CI = 1.02, 1.14), and summer (OR = 1.07; 95% CI = 1.00, 1.15). Table 3 shows the ORs and 95% CIs for the associations between 1 or more, 2 or more, 3 or more, and 4 or more consecutive cold days during the hazard period and the odds of OHCA in each season and all seasons combined.

Table 4 shows the results for the subgroup analyses by age and sex. The overall effect estimates were positive for all subgroups, with no notable effect modification by age or sex when all seasons were analyzed together. Subgroup analyses stratified by season suggested seasonal differences in vulnerability, however, but there was heterogeneity in the estimates.

The extensive sensitivity analyses showed that the results of the study were robust under changes in modeling choices and underlying assumptions (full disclosure in Tables A, B, and

TABLE 1— Characteristics of the Study Population of Out-of-Hospital Cardiac Arrest Cases: Helsinki, Finland, 1997–2018

Characteristic	Autumn, No. (%)	Winter, No. (%)	Spring, No. (%)	Summer, No. (%)	All Seasons, No. (%)
All	1359 (100.0)	1575 (100.0)	1478 (100.0)	1265 (100.0)	5677 (100.0)
Sex					
Male	893 (65.7)	1018 (64.6)	983 (66.5)	811 (64.1)	3705 (65.3)
Female	466 (34.3)	557 (35.4)	495 (33.5)	454 (35.9)	1972 (34.7)
Age, y					
18–64	535 (39.4)	558 (35.4)	612 (41.4)	532 (42.1)	2237 (39.4)
≥ 65	824 (60.6)	1017 (64.6)	866 (58.6)	733 (57.9)	3440 (60.6)
Presumed etiology					
Cardiac	935 (68.8)	1074 (68.2)	992 (67.1)	838 (66.2)	3839 (67.6)
Noncardiac	424 (31.2)	501 (31.8)	486 (32.9)	427 (33.8)	1838 (32.4)
Primary rhythm					
VF or VT	499 (36.7)	495 (31.4)	481 (32.5)	377 (29.8)	1852 (32.6)
ASY or PEA	852 (62.7)	1075 (68.3)	991 (67.1)	883 (69.8)	3801 (67.0)
Not recorded	8 (0.6)	5 (0.3)	6 (0.4)	5 (0.4)	24 (0.4)
Decade					
1997–2007	690 (50.8)	827 (52.5)	740 (50.1)	655 (51.8)	2912 (51.3)
2008–2018	669 (49.2)	748 (47.5)	738 (49.9)	610 (48.2)	2765 (48.7)

Note. ASY = asystole; OHCA = out-of-hospital cardiac arrest; PEA = pulseless electrical activity; VF = ventricular fibrillation; VT = ventricular tachycardia.

C, available as supplements to the online version of this article at http://www.ajph.org).

DISCUSSION

This case–crossover study showed positive associations between unseasonably cold weather and OHCA during all seasons, not just during winter. The findings are consistent with our hypothesis and robust under the several sensitivity analyses. Each additional cold day preceding the OHCA increased the odds of OHCA by approximately 7%, with similar strength of association during the autumn, winter, spring, and summer. Similar exposure–response patterns were produced by both analytical approaches. All investigated subgroups displayed increased odds of OHCA associated with unseasonably cold weather. Season-specific subgroup analyses suggested seasonal differences in vulnerability to the weather events, but there was heterogeneity in the estimates.

TABLE 2— Descriptive Statistics of Daily Temperatures, in Degrees Celsius, at the Centrally Located Käpylä Rescue Station: Helsinki, Finland, 1997–2018

Statistic	Autumn, °C	Winter, °C	Spring, °C	Summer, °C	All Seasons, °C
Mean (SD)	6.6 (5.7)	−3.5 (6.1)	4.7 (6.5)	16.8 (3.3)	6.2 (9.1)
Range	42.8	41.3	51.0	32.8	62.8
Lowest minimum	−18.3	−30.6	−21.7	0.6	−30.6
Highest maximum	24.5	10.7	29.3	32.2	32.2
5th percentile threshold	−3.3	−15.9	−6.4	11.6	−9.2
Quartile					
Q1	2.7	−6.7	0.6	14.6	0.0
Q2	6.8	−2.1	4.4	16.6	5.9
Q3	11.1	0.9	9.5	18.9	13.9

TABLE 3— Associations Between Number of Cold Days During the Hazard Period and the Odds of Out-of-Hospital Cardiac Arrest by Season: Helsinki, Finland, 1997–2018

Days	Autumn, OR (95% CI)	Winter, OR (95% CI)	Spring, OR (95% CI)	Summer, OR (95% CI)	All Seasons, OR (95% CI)
≥ 1[a]	1.12 (0.96, 1.30)	1.16 (1.01, 1.33)	1.20 (1.05, 1.39)	1.12 (0.97, 1.30)	1.15 (1.07, 1.24)
≥ 2	1.15 (0.95, 1.38)	1.13 (0.93, 1.37)	1.14 (0.95, 1.37)	1.21 (0.98, 1.49)	1.16 (1.05, 1.27)
≥ 3	1.15 (0.86, 1.52)	1.31 (1.01, 1.71)	1.12 (0.85, 1.47)	1.53 (1.11, 2.09)	1.25 (1.09, 1.44)
≥ 4	1.67 (1.08, 2.59)	1.42 (1.02, 1.98)	1.39 (0.85, 2.25)	1.43 (0.61, 3.39)	1.47 (1.18, 1.84)
Per day[b]	1.06 (1.00, 1.12)	1.06 (1.01, 1.12)	1.08 (1.02, 1.14)	1.07 (1.00, 1.15)	1.07 (1.04, 1.10)

Note. CI = confidence interval; OR = odds ratio.

[a] Estimates for the ≥ 1-, ≥ 2-, ≥ 3-, and ≥ 4-day durations were derived by using the respective number of consecutive seasonally defined cold days as a dichotomic predictor, and each model was run separately.

[b] Estimates for odds per each additional cold day were derived by using the absolute number of seasonally defined cold days (0–7) as a continuous predictor in the model.

Validity of Results

The study had several limitations. A limitation of the study was the general difficulty of determining the primary cause of OHCA from prehospital records.[33] We used the Helsinki Cardiac Arrest Registry, which is prospective by nature[34,35] and includes detailed individual information on all consecutive cases of OHCA in the area in Utstein-compliant format.[33] Each entry to the registry is made right after the OHCA, minimizing recall bias. We manually cross-validated data by using event descriptions and the findings of medico-legal autopsy and coronary angiography, minimizing selection bias. The diagnostic criteria are homogenic throughout the registry. Another limitation of the study was that it was not possible to be certain that all cases had spent time at the service areas where they experienced the OHCA. Widespread exposure misclassification is not likely and would not contribute toward coherence of the effect estimates seen here. Another limitation of the study was the relatively small number of OHCA cases in Helsinki across the 22-year period, which introduced statistical heterogeneity in the estimates. We conducted the main analyses in 2 complementary ways, and these results together displayed a coherent pattern of increasing odds of OHCA during cold weather in all seasons.

A strength of the study was the design, which examined the temperatures in the seasonal context in which they occurred. This provided a complementary perspective to the phenomenon of adverse health effects attributable to moderately low temperatures.[1] Another strength was the season-specific definition of cold weather. As opposed to the standard definition of cold spell,[2] which implicitly captures cold spells during the coldest months of the year, our method

TABLE 4— Associations Between an Increasing Number of Cold Days During the Hazard Period and the Odds of Out-of-Hospital Cardiac Arrest in Different Sex and Age Groups by Season: Helsinki, Finland, 1997–2018

Subgroup	Autumn, OR (95% CI)	Winter, OR (95% CI)	Spring, OR (95% CI)	Summer, OR (95% CI)	All Seasons,[a] OR (95% CI)
Age 18–64 y	1.08 (0.99, 1.18)	1.02 (0.93, 1.11)	1.05 (0.96, 1.15)	1.13 (1.01, 1.26)	1.06 (1.02, 1.12)
Age ≥ 65 y	1.05 (0.97, 1.13)	1.09 (1.02, 1.16)	1.10 (1.03, 1.18)	1.03 (0.94, 1.13)	1.07 (1.03, 1.11)
Male	1.05 (0.98, 1.12)	1.06 (0.99, 1.13)	1.02 (0.95, 1.09)	1.14 (1.04, 1.24)	1.06 (1.02, 1.10)
Female	1.09 (0.99, 1.19)	1.08 (0.98, 1.18)	1.20 (1.09, 1.31)	0.96 (0.85, 1.09)	1.09 (1.04, 1.15)

Note. CI = confidence interval; OR = odds ratio. All estimates were derived by using the absolute number of seasonally cold days (0–7) as a continuous predictor in the model.

[a] Estimate for all seasons was derived by including all cases in the analyzed subgroup, irrespective of the season of occurrence, into the analysis.

produced season-specific estimates for all seasons, not just winter.[15,16] We compared the probability of cold weather between 2 period types, which controlled for individual attributes and changes in them over time. We used modeling choices to adjust for long time trends, and other temporal, time-varying and time-invariant confounders were controlled by design. The 7-day hazard period accommodates potential time lags between cold weather and OHCA.[9,12,15,16] The rescue stations were linked with high-resolution weather data that took into account geographical differences among locations, which can be important in a coastal city like Helsinki. The weather data were validated, and instrumentation bias was minimal. Finally, we conducted several sensitivity analyses to assess robustness of the results.

Synthesis With Previous Knowledge

Our findings are consistent with previous evidence on the associations between cold weather and OHCA.[9–14,18] In addition, we explicitly showed that similar associations exist in all seasons. Our findings are not in contrast with the substantial evidence of winter peaks in cardiovascular disease mortality or morbidity,[6] nor are they in contrast with evidence on seasonal variation of OHCA incidence or survival.[38,39] Even if an outcome is more common during month A, its association with an independent environmental stressor can be stronger during month B. Our findings are in agreement with previous evidence on adverse health effects of moderately cold weather.[1,18] The methods are not directly comparable but provide mutually complementary information.

In our data, the highest maximum temperature of winter (10.7°C) was colder than the 5th percentile of summer temperatures (11.6°C). The population of Finland is well-prepared to face 10°C weather in winter, because the infrastructures of society, heating of indoor environments, heating of transportation vehicles, insulative winter clothing, and attitudes of the population are seasonally adapted. But experiencing 10°C summer weather in Finland may be disastrous: the indoor environments have been precooled rather than heated, the population is accustomed to dressing lightly in shorts and short-sleeved shirts, and the perception of risk may be inadequate across the society. Just as it would not make sense to issue a public health warning of 10°C winter weather in Finland, it might not make sense not to issue a public health warning of 10°C summer weather in the same setting. We did not assess whether some absolute temperature level during the summer season is more hazardous to health than the identical temperature level in the winter season, but this example opens up interesting new hypotheses and illustrates why considering the seasonal context of temperatures could be meaningful.

In our subgroup analyses, the elderly seemed most vulnerable to the effects of cold winter weather. This is consistent with previous evidence on winter cold spells.[2] Women seemed most vulnerable to the effects of cold spring weather, which may provide important mechanistic clues for future studies. For example, the majority of cases in which pulmonary embolism was suspected as the underlying cause of OHCA occurred during the spring (32%) and in women (4.4% of all women compared with 2.1% of all men). However, our data did not permit further speculation. Young men seemed most vulnerable to the effects of cold summer weather. We suspect that behavioral factors, such as prolonged outdoor activities, limited clothing, or increased alcohol consumption during the summer, may play a role. We recognize the possibility that some of these subgroup differences could be explained by chance. Their value is in the demonstration that classification of vulnerability to cold weather may not stay constant over annum.

Biological foundations for explaining cardiovascular aggravation during cold weather have been laid out over a century of experimental work.[5,19,40,41] Cutaneous vasoconstriction, driven by the autonomic nervous system, is the major and immediate thermoregulatory response to cold in humans. It leads to increases in systemic vascular resistance, cardiac preload, cardiac afterload, and myocardial workload.[5,19,41] Cutaneous vasoconstriction begins when skin temperature falls below 35°C, and becomes maximal at moderate ambient temperatures.[19,41] Relevant cardiovascular responses are consistently reported during ambient moderate cold exposures in experimental settings. In a study by Keatinge et al.,[24] 6-hour exposure to moving air at 24°C induced an increase in arterial pressure from 126/69 millimeters mercury to 138/87 millimeters mercury. The authors also reported increased blood viscosity, an increased thrombocyte count, and increased mean thrombocyte volume to produce a 15% increase in the fraction of plasma volume occupied by thrombocytes. Mäkinen et al. exposed patients to 10°C ambient temperature for 2 hours.[21] The patients were wearing shorts, socks, and athletic shoes.

The authors reported increases in systolic and diastolic blood pressure, increased plasma noradrenaline levels, and changes in autonomic nervous system function. Nagelkirk et al. exposed resting patients to 5°C or 8°C ambient temperature for 15 minutes,[20] followed by a maximal cycle ergometer test in the same temperature. Exposure to the cold air induced a prothrombotic state before and after the exercise. Mercer et al. exposed patients to 11°C ambient temperature for 1 hour[22] and concluded that the moderate cold exposure induced a mild inflammatory reaction and a tendency for an increased state of hypercoagulability. Neild et al. exposed patients to 18°C moving air for 2 hours.[23] With little change in core temperature, this exposure significantly increased plasma fibrinogen concentrations from 2.97 grams per liter to 3.39 grams per liter. Plasma concentrations of factor X and protein C did not increase significantly.

Humans also undergo short-term, long-term, and seasonal thermophysiological adjustments, acclimatizing to heat during the summer and to cold during the winter.[25] The evidence suggests that humans are less prepared to face cold thermal challenges when the timing is in contrast with seasonal acclimatization.[25–27,29,30] The evidence also suggests that while habituation can take place during these weather events, aggravated physiological responses are likely before the physiological adjustments take place.[21,28] To make the topic more complex, seasonal variations in factors like blood pressure, serum lipid concentration, and diet can have relations with low temperature, cardiovascular health, or both, in the acute and chronic setting.[6] However, these factors are at best mediators or modifiers in the current study design, and as such out of the scope of further speculation.

To summarize, experimental evidence supports the hypothesis that moderate cold exposures during all seasons can be hazardous to health. More elaborate assessment of these phenomena in the epidemiological setting could provide new insights.

Public Health Implications

The Network of European Meteorological Services provides real-time warnings of cold spells throughout Europe. These events are defined in circannual terms and occur in the winter (http://www.meteoalarm.org). So do the cold weather events defined by the National Weather Service of the National Oceanic and Atmospheric Administration in the United States (https://www.weather.gov/safety/cold). The warnings issued by the Finnish Meteorological Institute are based on temperatures between −20°C and −45°C as indicators for health risk (https://en.ilmatieteenlaitos.fi/warnings-on-hot-and-cold-weather). The Toronto Cold Weather Program in Canada has been operational since 1996 and uses −15°C as trigger for public health action.[17] The Cold Weather Plan for England mentions winter 220 times, summer zero times, autumn zero times, and spring once (in an unrelated context).[4] These and many other programs explicitly or implicitly confine the cold-related public health action to the winter season.

If cold weather causes adverse health effects during all seasons, is it justified to limit public health action to the winter months? Should the general public not at least be informed? If the majority of health effects are attributed to moderately low temperatures,[1] would protection from moderately low temperatures not have the greatest potential of reducing excess mortality? If the relation between cold weather and health effects is truly loglinear and constant over the calendar year,[42] would similar reduction in exposure not lead to similar public health benefits in all seasons and, if the relationship varies by season instead, would it not be critical to take this into account in public health planning? Our study did not answer these questions per se, but we hope to have made a reasonable case for looking more closely into the seasonal context of temperatures in future assessments. The patterns observed in Helsinki cannot be assumed to be generally applicable elsewhere, but, together with the presented literature, they stimulate universal questions that could have major implications for the assessment of weather-related mortality and, consequently, for public health policy and practice. The fundamental question remains: how should cold weather be defined for the monitoring and managing of public health? AJPH

ABOUT THE AUTHORS

Niilo R. I. Ryti is with the Center for Environmental and Respiratory Health Research (CERH), Faculty of Medicine, University of Oulu, and Medical Research Center Oulu, University of Oulu and Oulu University Hospital, Oulu, Finland. Jouni Nurmi, Ari Salo, and Markku Kuisma are with the Department of Emergency Medicine and Services, Helsinki University Hospital, Helsinki, Finland. Harri Antikainen is with the Geography Research Unit, University of Oulu. Jouni J. K. Jaakkola is with CERH, Faculty of Medicine, University of Oulu, and Medical Research Center Oulu, University of Oulu and Oulu University Hospital, and the Finnish Meteorological Institute, Helsinki.

CORRESPONDENCE

Correspondence should be sent to Niilo R. I. Ryti, Center for Environmental and Respiratory Health Research (CERH), PO Box 5000, FI-90014, University of Oulu, Oulu, Finland (e-mail: niilo.ryti@oulu.fi). Reprints can be ordered at http://www.ajph.org by clicking the “Reprints” link.

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CONTRIBUTORS

N. R. I. Ryti initiated and designed the study, executed the statistical programming and analyses applying the new methodological concept created by N. R. I. Ryti and J. J. K. Jaakkola, and drafted the article with intellectual input from all authors. J. Nurmi co-initiated the study with N. R. I. Ryti, retrieved ethical clearance for the study, assisted in designing the case eligibility criteria, provided clinical and scientific expertise in cardiac arrest, and provided intellectual input for the interpretation of results. A. Salo was responsible for the cardiac arrest registry including the measures of quality control, performed the final case selection, provided clinical expertise on the diagnostics and treatment of cardiac arrest patients in Helsinki, and provided intellectual input for the interpretation of results. M. Kuisma provided clinical and scientific expertise on emergency medical services and cardiac arrest, and provided intellectual input for the interpretation of results. H. Antikainen performed the geographic information system programming, extracted and validated the time-series of weather for the study, and provided intellectual input for the geospatial variation of weather in the study area and interpretation of the results. J. J. K. Jaakkola co-created the new methodological concept with N. R. I. Ryti, provided expertise in modeling the health effects of weather, and provided intellectual input for the interpretation of results.

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CONFLICTS OF INTEREST

The authors declare no potential or actual conflicts of interest.

HUMAN PARTICIPANT PROTECTION

The study protocol was approved by institutional review board at the Hospital District of Helsinki and Uusimaa, Finland (HUS/278/2018).

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Federal Statutes and Environmental Justice in the Navajo Nation: The Case of Fracking in the Greater Chaco Region

Mario Atencio, MA, Hazel James-Tohe, Samuel Sage, David J. Tsosie, EdD, Ally Beasley, JD, MPH, Soni Grant, PhD, MA, and Teresa Seamster, EdS, MS

See also Levy and Hernández, p. 48.

Arguing for the importance of robust public participation and meaningful Tribal consultation to address the cumulative impacts of federal projects, we bridge interdisciplinary perspectives across law, public health, and Indigenous studies. We focus on openings in existing federal law to involve Tribes and publics more meaningfully in resource management planning, while recognizing the limits of this involvement when only the federal government dictates the terms of participation and analysis.

We first discuss challenges and opportunities for addressing cumulative impacts and environmental justice through 2 US federal statutes: the National Environmental Policy Act and the National Historic Preservation Act. Focusing on a major federal planning process involving fracking in the Greater Chaco region of northwestern New Mexico, we examine how the Department of the Interior attempted Tribal consultation during the COVID-19 pandemic. We also highlight local efforts to monitor Diné health and well-being.

For Diné people, human health is inseparable from the health of the land. But in applying the primary legal tools for analyzing the effects of extraction across the Greater Chaco region, federal agencies fragment categories of impact that Diné people view holistically. (*Am J Public Health*. 2022;112(1):116–123. https://doi.org/10.2105/AJPH.2021.306562)

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Diné (Navajo) communities in the Greater Chaco region of northwestern New Mexico have raised concerns that the Department of the Interior (DOI) has not engaged in meaningful public involvement and Tribal consultation to inform its decisions about oil and gas development. For Diné people, human health is inseparable from the health of the land. But in applying the primary legal tools for analyzing the effects of extraction across the Greater Chaco landscape, federal agencies tend to fragment categories of impact that Diné people view holistically. Because of federal agencies' failure to collaborate with communities most affected by extraction, the DOI, under previous leadership, has acted based on incomplete information about existing and potential direct, indirect, and cumulative impacts.

How federal agencies approach public participation and Tribal consultation has critical implications for environmental justice. Requirements in US federal laws such as the National Environmental Policy Act (NEPA) and the National Historic Preservation Act of 1966 (NHPA) establish minimum standards for meaningful engagement with frontline communities, sovereign Tribal nations, and broader publics, but following these standards does not guarantee equitable, just processes or outcomes. In arguing this, we firmly believe that nothing short of a redistribution of power, which includes "the repatriation of Indigenous land and life,"[1(p21)] will truly bring about environmental justice. But in this article, we focus on openings in existing federal law to involve Tribes and publics more meaningfully in resource management planning and decision-making, while recognizing the limits of this involvement when only federal actors dictate the terms of participation and analysis.

We stress that the caretaking of Indigenous homelands is a public health and environmental justice issue for Diné people. Extraction in the Greater Chaco, as well as the control of Diné lands by non-Native actors, can interfere with the ability of Diné people to practice these relations of care. We point to Diné Fundamental Law as an example of where the inseparability of human and environmental well-being in a Diné worldview is expressed. We do not offer interpretations of fundamental law or expand in detail on Diné epistemology regarding relationships between humans and other beings, but we highlight these ways of knowing to signal some of their core differences from a Euro-American worldview. These differences, we suggest, are often problematically glossed over in federal decision-making.

Controversy over a Draft Resource Management Plan Amendment and Environmental Impact Statement (RMPA-EIS) for the Bureau of Land Management's (BLM's) Farmington Field Office in northwestern New Mexico exemplifies the critical nexus of public participation, Tribal consultation, health, and environmental justice. In process since 2014, the draft RMPA-EIS was released for public comment just as the COVID-19 pandemic devastated Indigenous communities across the region. Although the BLM has not yet made a final decision on the RMPA-EIS, it is worth examining the thus far 7-year process and the content of this draft plan for the coloniality it reveals in the federal oil and gas program.

The Navajo Nation chapters (local units of government) of Counselor, Ojo Encino, and Torreon, which together form the Tri-Chapter Council, are in the heart of contentious new and ongoing hydraulic fracturing ("fracking") development near Chaco Culture National Historical Park, which the RMPA-EIS is meant to analyze. The Tri-Chapter Council is in an eastern part of Diné homelands called Dinétah, the place of emergence of Diné people into this world. Diné homelands are bound by 6 sacred mountains. To the east is Sis Naajiní, to the south Tsoodził, to the west Dook'o'oosłííd, and to the north Dibé Nitsaa. Dinétah, marked by the last 2 sacred mountains, Dził Na'oodilii and Dził Ch'ool'il, symbolizes a doorway into these homelands. Diné people have lived in Dinétah since time immemorial, caring for the land as instructed by the Holy People.[2,3]

Yet despite the paramount importance of Dinétah in Diné cosmology and the prevalence of sacred sites throughout the region, much of the land base is controlled by federal, state, and private actors—not by the Navajo Nation government. Many of the Navajo chapters in Dinétah are outside the formal reservation boundaries. Over the course of colonial settlement, Diné homelands were surveyed and divided into distinct tracts of land over which the federal government claimed jurisdiction––and then granted piecemeal to settlers, the State of New Mexico, and some individual Diné allotment owners. The result is a "checkerboarded" legal landscape: a complex patchwork of federal, state, private, Tribal trust, and Indian allotted jurisdictions. Because of the fragmentation of Diné territory in the region, the BLM and the Bureau of Indian Affairs (BIA) have the enforced legal authority to make most decisions regarding oil and gas development there.[2,3] Because of the proximity of ongoing and potential fracking to Chaco Culture National Historical Park and the importance of the Greater Chaco landscape to Diné, Pueblo, Hopi, and Apache peoples, controversy over extraction in this region has garnered substantial national attention.[4]

Taking the Farmington draft RMPA-EIS as a case study in which the COVID-19 pandemic rendered already inadequate consultation processes nearly impossible, we show why it is imperative that public participation and Tribal consultation not be treated merely as box-checking exercises for federal agencies. Instead, as exemplified by Diné residents documenting the impacts of fracking in the Tri-Chapter Council, frontline communities have a wealth of important knowledge about the actual and potential effects of extraction (Appendix A [available as a supplement to the online version of this article at http://www.ajph.org]). This knowledge should guide collaborative decision-making about land management and infrastructure projects.

RESOURCE MANAGEMENT PLAN AMENDMENT

In 2014, the BLM announced it would launch a public process to amend the resource management plan for its Farmington Field Office in northwestern New Mexico. Resource management plans are major planning documents that outline how a BLM field office will administer federally managed lands and resources in its jurisdiction over a long period, usually about 20 years. The last resource management plan for the Farmington Field Office was finalized in 2003. At that time, the BLM had not anticipated that by 2010 oil and gas companies would flock to the region's San Juan Basin to extract oil from a previously untapped hydrocarbon reservoir, the Mancos Shale. Instead, the BLM had planned for long-standing "conventional" oil and gas development to continue as it had in previous years.[5]

The purpose of the RMPA-EIS process was to supplement the analysis in the 2003 resource management plan by accounting for the impacts of Mancos Shale development. In 2016, the BIA joined the BLM as a coleading agency in the preparation of the RMPA-EIS, which the BIA would use to guide mineral-leasing decisions on Tribal trust and Indian allotted lands.[6]

As the BLM and the BIA undertook a process to analyze the impacts of Mancos Shale development, the agencies proceeded to permit new extraction from Mancos Shale. In a region with more than 40 000 active and abandoned oil and gas wells, where more than 91% of federally managed lands are already leased for oil and gas extraction, this alarmed Tribal governments and many affected community members.[7] The Navajo Nation, the All Pueblo Council of Governors, and the National Congress of American Indians adopted resolutions requesting that the BLM enact a moratorium on new leasing and drilling on federally managed lands until the RMPA-EIS was finalized.[8–10] The DOI did not heed to these demands. Instead, between 2010 and 2021, its bureaus authorized drilling permits for more than 400 new Mancos Shale wells, whose potential cumulative impacts had never been analyzed. Indigenous and environmental advocates continue to challenge these actions in federal court.[7]

The National Environmental Policy Act

The NEPA is a federal statute that outlines procedural requirements for how federal agencies should assess and disclose the potential environmental impacts of federal projects, with a goal of protecting and enhancing the human environment.[11] To accomplish this goal, NEPA has 2 broad aims: (1) ensuring public participation and transparency in federal agency decision-making, and (2) ensuring that federal agency decision-makers are fully informed of, and thoroughly consider, all the relevant factors and potentially significant impacts of their decisions (42 USC §§4321, 4331). These twin aims should be mutually reinforcing. A full public participation process, with the "fair treatment and meaningful involvement"[12] that environmental justice demands, is necessary to apprise agencies and publics of "relevant factors," including comprehensive cumulative risks and impacts that can only be fully understood through collaboration with those who experience these impacts.[13]

The NEPA's implementation of Council on Environmental Quality (CEQ) regulations, as originally written, required agencies to consider cumulative impacts in their decision-making and planning processes—specifically, in NEPA's requisite Environmental Assessments or Environmental Impact Statements (40 CFR §1508.25(c)(3)). These CEQ regulations define cumulative impacts as

> the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 CFR §1508.7)

The "environment," in turn,

> shall be interpreted *comprehensively* to include the natural and physical environment *and the relationship of people with that environment.* (40 CFR §1508.14; emphasis added)

This relationship includes, but should not be limited to or compartmentalized into, physical, biological, and social forces.[11]

It is critical for advancing environmental justice in and through the NEPA process that the relationship between people and the environment be viewed from the perspective of those who know it firsthand. Environmental assessments must not be confined to a Euro-American worldview characterized by what Dongoske et al. call "scientific materialism," a lens that views ecosystems as composed of discrete parts, whose variables and interactions can be studied.[11] Although this worldview has tended to dominate NEPA processes, Indigenous peoples often have other ways of understanding the environment that "get short shrift in NEPA analyses."[11(p41)] A focus on single-pollutant, risk-based modeling in US federal environmental laws and regulations has excluded other valid perspectives and sources of knowledge from decision-making and has led agencies to compartmentalize impacts, and even pollutants, and to dismiss their significance accordingly.[11]

For example, in DOI's draft Farmington RMPA-EIS, the department bracketed the impacts of fracking and oil and gas development authorized by the plan into discrete categories, such as "cultural," "health," "economic," "climate," "air quality," and "water quality."[14] This segregation of impacts does not reflect the perspectives and information shared by Tribal governments and frontline communities for the years leading up to the draft RMPA-EIS.[6] The DOI occasionally briefly discussed cumulative impacts in some of these categories in the draft RMPA-EIS, but did not appear to consider the relationships of these impacts to one another or to consider these and other impacts as they are identified and documented by those who live in the Greater Chaco region (Appendix A).

Diné Fundamental Law, ordained by the Holy People and formally enacted by the Navajo Nation Council in 2002, is an example of a long-standing juridical tradition that operates with a different understanding of the relationship between humans and the environment than that which the BLM assumes when applying NEPA, where "humans," "environment," and "culture" are treated as separate categories of analysis.[15] No such distinctions are made in Diné Fundamental Law, whose purpose is to "provide sanctuary for the Diné life and culture, our relationship with the world beyond the sacred mountains, and the balance we maintain with the natural world."[16(p6)] The integral relationship between Diné people and the environment is articulated in Diné Fundamental Law as follows:

> Mother Earth and Father Sky is part of us as the Diné and the Diné is part of Mother Earth and Father Sky; the Diné must treat this sacred bond with love and respect without exerting dominance for we do not own our mother and father. (1 NNC §205)

As expressed in Diné Fundamental Law and by Tri-Chapter Council residents, the continuation of Diné culture is bound up with care for the broader environment, which is, simultaneously, care for the people and kinship relationships (Appendix A).[3]

In 2020, the Trump administration gutted NEPA regulations and targeted sections at the heart of environmental justice—striking the mandates that agencies consider indirect and cumulative impacts and further eviscerating public participation requirements. If the Biden administration restores or strengthens the original CEQ regulations, it is critical that such revisions be drafted and reviewed with those in frontline communities as colleagues from the outset.

Regardless of the state of the CEQ regulations, US state and federal courts have held that federal agencies must take a "hard look" at environmental justice in their NEPA analyses and processes. In doing so, they have looked to the language of NEPA, Executive Order 12898 on environmental justice, and agency guidance on environmental justice in the NEPA process.[17] For example, in recent rulings on challenges to the Dakota Access Pipeline,[18] the court looked to the CEQ Guidance on Environmental Justice in the NEPA process and ruled that it was not enough for an Army Corps of Engineers environmental assessment merely to acknowledge that the Standing Rock community had a high percentage of "minorities" and "low-income individuals" and could be affected by an oil spill from the Dakota Access pipeline. The court noted that the environmental assessment was silent on the "cultural practices of the Tribe and the social and economic factors that might amplify its experience of the environmental effects of an oil spill"[18(p54)] and that to meet its NEPA "hard look" obligations, the agency "needed to offer more than a bare-bones conclusion that Standing Rock would not be disproportionately harmed."[18(p54)] In a subsequent memorandum opinion, the court stated that "In this Circuit, NEPA creates, through the Administrative Procedure Act, a right of action deriving from Executive Order 12898"[19(p4)] and that NEPA further requires the agency to determine how a project will affect a Tribe's treaty rights.[19]

The National Historical Preservation Act

The NHPA is a federal statute intended to preserve historic and archaeological sites across the United States. NHPA's Section 106 requires federal agencies to consider how federally approved or funded projects, like the Farmington RMPA-EIS, may affect historic properties as defined by law.[11,20] Section 106 mandates that federal agencies consult with Tribes, Alaska Natives, and Native Hawaiian Organizations, as well as the state historic preservation officer and the tribal historic preservation officer, regarding federal projects. Additionally Section 106 guides federal agencies to collaborate with these parties in identifying historic properties, assessing the potential effects of a project on these properties, and developing strategies to mitigate adverse effects.

Tribal consultation with the Diné Nation and the Pueblo Nation regarding the Farmington RMPA-EIS has occurred primarily under the framework of Section 106. However, Indigenous communities across the Greater Chaco region have raised concerns about the adequacy of this consultation process and the lack of thorough ethnographic surveying that should accompany Section 106 analyses, arguing that the DOI has failed to meaningfully consult with Indigenous peoples and governments during the RMPA-EIS process, quarterly oil and gas leasing, and regular permitting activities.

For example, Samuel Sage, community services coordinator for Counselor Chapter and coauthor of this article, describes his experience of "consultation" with DOI on the Draft RMPA-EIS as follows:

> I have never once experienced BLM come to Counselor Chapter and actually listen to residents' concerns. When BLM does occasionally show up, it is to inform us of a decision the agency has effectively already made and then to defend that decision without taking our community's feedback into account. This is how the NHPA Section 106 process for the RMPA-EIS felt as well—like BLM had already decided they wanted to approve more oil and gas development in our area, and Tribal consultation was just a formality they had to go through beforehand. This is not meaningful consultation. (Counselor Chapter, NM, September 23, 2020)

Sage's experience underscores how the minimum standards established by law do not ensure meaningful consultation. Like NEPA, NHPA is a procedural statute. Courts have tended to uphold agencies' decisions to authorize projects even if doing so will result in adverse effects to cultural properties, so long as the procedural benchmarks of the law have been met.[21,22] However, in the Greater Chaco region, DOI decisions have resulted in significant consequences for environmental justice in both the Counselor Chapter and the broader Tri-Chapter Council communities. Because fracking began in the Tri-Chapter Council, residents have noticed increased and constant air pollution, disappearance of medicinal plants, degradation of local roads, and increased health effects (Appendix A).

These concerns reflect the long-term presence of oil and gas development across the Greater Chaco landscape, where Diné communities are surrounded by extraction. However, the BLM's methods under both NEPA and NHPA for assessing oil and gas proposals rely on a tiered scalar analysis that undermines the agency's ability to understand these cumulative impacts and their effects on the well-being of Diné and Pueblo communities. For example, the BLM defers its site-specific examination of potential cultural resource impacts to the drilling permit stage, right before a site is prepared for extraction.[23] At this point in the review process, oil and gas leases have already been approved and the lessee has secured a legal right to develop minerals. Minor modifications to the project may be made to mitigate impacts to cultural resources—for instance, a culvert may be moved over by a few feet to avoid a medicinal plant—but the project is unlikely to be stopped. This method bespeaks distinctly colonial assumptions about land inherent to the BLM's management practices: that, once parceled out and sold, impacts to one piece of land can be examined in isolation from the landscape of which it is a part. By contrast, for Diné the land is a living entity. Like a human body, all its parts are connected.

Diné and Pueblo groups have argued that the BLM could reduce some of its blind spots regarding impacts to cultural resources by involving Tribes and Indigenous communities early and often in decision-making regarding federal land use planning and leasing through processes of meaningful consultation and consent.[24] These groups also remind the BLM that a congressionally funded ethnographic study, led by the pueblos of Acoma, Jemez, Laguna, and Zuni, the Hopi Tribe, and the Navajo Nation, is under way and should inform future land use plans.[25] That this study is led by Indigenous experts is significant because, as Diné and Pueblo people have consistently pointed out, only experts from their own communities have the knowledge required to identify many cultural sites.[6]

Even when ethnographic studies are conducted, Indigenous peoples face challenges in rendering their concerns about the protection of sacred lands intelligible to federal agencies and courts. NHPA's strict criteria for listing on the National Register of Historic Places, its tendency to value written evidence over oral histories, and the burden of demonstrating an impact to sacred sites under the law, all limit the usefulness of NHPA for Indigenous peoples in protecting sacred places.[26] Moreover, some Indigenous religious practices require keeping private the location and purpose of sacred sites, which can make it challenging for Tribes to present all the evidence needed to advocate the recognition of a place or site as a "historic property" under the NHPA.[27]

Examining cases where Tribes have brought legal challenges against federal agencies' decisions regarding cultural resources, the author (D. J. T.) notes that courts have tended to consider sovereign Tribal governments just one set of "stakeholders" in a broader conversation about public lands management.[20] This tendency glosses over the special government to government relationship that Tribes have with the United States, as well as the unique nature of Indigenous claims to place. The propensity in US jurisprudence to adjudicate resource conflicts in terms of competing property claims between Tribes and other parties, like potential developers, often falls woefully short of what Tribes argue in such cases.[20] For instance, in the Greater Chaco region, Diné and Pueblo peoples advocating landscape-level protection are doing so to affirm not an individual right to property but an expansive set of collective and cultural rights and responsibilities to care for the land.[20,26]

Federal laws like NHPA and NEPA tend to require Indigenous peoples to articulate their positions in the constraining frameworks of Euro-American juridical traditions, and federal agencies have typically treated Tribal consultation as merely a right to be involved, at best. But meaningful consultation conducive to an understanding of the cumulative and environmental justice impacts of federal projects must begin from a place where Indigenous peoples can "effectively determine the outcome of decision-making that affects them."[28,29] This means that the terms of participation and analysis cannot be presumed by federal institutions in advance.

Participation and Consultation

On February 28, 2020, just weeks before the Navajo Nation, the Pueblo Nations, and the State of New Mexico implemented stay-at-home orders in response to the COVID-19 pandemic, the DOI released a draft of the long-anticipated Farmington RMPA-EIS. The scenarios, or "alternatives," presented in the plan did not reflect public feedback provided during scoping in previous years, during which commenters overwhelmingly asked the DOI to end new oil and gas development in the region.[6] Instead, the alternatives presented would allow the drilling of 2345 to 3101 new oil and gas wells, signaling to affected communities that their feedback about the destructive impacts of extraction had not been meaningfully taken into account.[14]

The release of the draft RMPA-EIS triggered a 90-day public comment period. Despite requests from Tribes, Pueblos, elected representatives, environmental groups, and publics that the comment period be extended until in-person public meetings could be safely held, the DOI opted to hold virtual forums to solicit feedback on the plan. At the 11th hour, amid widespread public outcry, the agencies extended the comment period by another 90 days. However, as the close of that comment period drew near, the impacts of the COVID-19 pandemic across the region had only worsened. The DOI ignored continued requests for a pause in the process and continued instead to host largely inaccessible virtual meetings.[30]

The week that the DOI launched its first round of virtual meetings in May 2020, the Navajo Nation recorded the highest per capita rate of COVID-19 infections in the United States.[31] Indigenous communities in New Mexico and across the country were devastated by the pandemic. Native American and Alaska Native peoples face a higher risk of COVID-19 infection and a mortality rate nearly twice that of non-Hispanic White populations.[32] Moreover, in the Greater Chaco region, as in many Indigenous communities, low-income communities, and communities of color,[22,33] residents are disproportionately exposed to harmful levels of air pollution from industrial sources, including oil, gas, and coal extraction.[34] These exposures compound COVID-19 risks.[34,35]

In addition to facing disparate COVID-19 impacts, many Diné and Pueblo communities do not have access to the broadband Internet or telephone coverage required to participate in virtual meetings. New Mexico ranks 49th in the United States for Internet access, and less than half of Indigenous residents have Internet access in their homes.[36,37] Tribal governments were not only concerned about barriers to their citizens' access to the virtual public meetings; elected leaders also insisted that meaningful consultation could not occur so long as Tribes remained focused on responding to the pandemic.

CONCLUSIONS

As of fall 2021, under new leadership, the DOI has not finalized the draft RMPA-EIS. It remains to be seen when the department will do so and under what conditions. Meanwhile, Tri-Chapter Council advocates continue to work toward environmental justice—in both process and outcomes—in the Greater Chaco region (Appendix A).

Current federal laws and regulations do not guarantee meaningful Tribal consultation and public participation—let alone environmental justice. These laws and regulations must be reimagined, with input from those they have served poorly. But, even in laws like NEPA as interpreted by courts to date, federal agencies can—and must—do more to advance environmental justice, as defined and understood by those who know firsthand the cumulative impacts of energy and infrastructure projects. For Diné residents of the Tri-Chapter Council, natural resources are cultural resources, and the health of people is inseparable from the health of the land. A cumulative impact assessment of existing and proposed fracking in the region must begin from this place. AJPH

ABOUT THE AUTHORS

Mario Atencio and Samuel Sage are with Diné Citizens Against Ruining Our Environment, Navajo Nation. Hazel James-Tohe is with the San Juan Collaborative for Health Equity, Navajo Nation. David J. Tsosie is with Diné Centered Research and Evaluation, Navajo Nation. Ally Beasley is with the Western Environmental Law Center, Taos, NM. Soni Grant is with the Department of Sociology and Social Anthropology, Dalhousie University, Halifax, NS. Teresa Seamster is with the Northern New Mexico Group, Rio Grande Chapter of the Sierra Club, Santa Fe, NM. Mario Atencio, Hazel James-Tohe, Samuel Sage, and David J. Tsosie are Diné and are members of the Navajo Nation.

CORRESPONDENCE

Correspondence should be sent to Soni Grant, Department of Sociology and Social Anthropology, Dalhousie University, Marion McCain Arts and Social Sciences Building, Room 1128, 6135 University Ave, PO Box 15000, Halifax NS B3H 4R2, Canada (e-mail: spgrant@dal.ca). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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The authors have no conflicts of interest to disclose.

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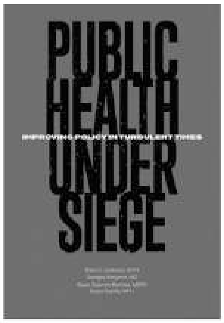

The EPA's Commitment to Children's Environmental Health: History and Current Challenges

Marianne Sullivan, DrPH, Leif Fredrickson, PhD, and Chris Sellers, PhD

See also Levy and Hernández, p. 48.

Children's environmental health (CEH) has a 25-year history at the US Environmental Protection Agency (EPA), during which the agency has advanced CEH through research, policy, and programs that address children's special vulnerability to environmental harm.

However, the Trump administration took many actions that weakened efforts to improve CEH. The actions included downgrading or ignoring CEH concerns in decision-making, defunding research, sidelining the Children's Health Protection Advisory Committee, and rescinding regulations that were written in part to protect children.

To improve CEH, federal environmental statutes should be reviewed to ensure they are sufficiently protective. The administrator should ensure the EPA's children's health agenda encompasses the most important current challenges and that there is accountability for improvement. Guidance documents should be reviewed and updated to be protective of CEH and the federal lead strategy refocused on primary prevention. The Office of Children's Health Protection's historically low funding and staffing should be remedied. Finally, the EPA should update CEH data systems, reinvigorate the role of the Children's Health Protection Advisory Committee, and restore funding for CEH research that is aligned with environmental justice and regulatory decision-making needs. (*Am J Public Health*. 2022;112(1): 124–134. https://doi.org/10.2105/AJPH.2021.306537)

The Trump administration's Environmental Protection Agency (EPA) was one of the most proindustry and antiregulatory in history.[1] Among its many actions to weaken environmental health generally, it substantially weakened regulatory protections for children,[2] a population with heightened vulnerability to environmental hazards, stalling and reversing progress made in the past few decades. Regulations that adequately protect children's environmental health (CEH) are typically more stringent than those for adults, and this stringency is often opposed by polluting industries.[3] Moreover, the agency weakened its environmental justice program, also relevant to CEH.[4]

This article draws on qualitative semistructured interviews with current and former EPA employees by researchers with the Environmental Data and Governance Initiative, media accounts, and government reports. A full description of our methods can be found in Sullivan et al.[5] In this essay, we provide a brief history of CEH at EPA, discuss accomplishments and challenges, and describe how the Trump administration weakened consideration of CEH within EPA and in agency rule-making. We end by making recommendations to review the regulatory framework for CEH and to strengthen the agency's prioritization of it in science and policy.

HISTORY

For almost 25 years, CEH (which encompasses environmental impacts on pregnancy, infancy, toddlerhood, childhood, and adolescence) has been a formal part of the EPA's responsibilities, and the agency has played a lead role in advancing CEH across the federal government.

Before its promotion in science and policy under the Clinton administration, CEH had largely been an afterthought. In the mid-1990s, only 3% of federal research funding addressed children, and the EPA spent the least of any federal agency.[6] Federal environmental laws did not require that regulatory standards protect infants and children. Most standards were set on the basis of harm to adult men.[7] However, because of their physiology, rapid development, and behaviors, infants and children have different and often greater exposure and susceptibility to environmental toxicants. Exposures during fetal development, infancy, and childhood can harm brain and other organ development, sometimes permanently and irreversibly, and can contribute to adverse health outcomes later in life.[8]

EPA's focus on CEH grew out of a Congressionally requested National Academy of Sciences (NAS) report *Pesticides in the Diets of Infants and Children* (1993), which addressed the relevance of US pesticide risk assessment and regulation to children.[9] The approach at the time set tolerances for pesticides on foods based on toxicity information drawn from effects on "sexually mature animals" and exposure data derived from "average adult consumption patterns."[9(p4,5)] It did not account for children's differential exposure and risk from dietary patterns, developmental toxicity, windows of vulnerability, or cumulative exposures. The NAS report recommended adopting a more health-based and precautionary approach to pesticide risk assessment and regulation to protect children, specifically to apply a 10-fold safety factor when "there is evidence of postnatal developmental toxicity" or when child-specific data are "incomplete."[10(p9)] The report led to the bipartisan passage of the Food Quality Protection Act of 1996, which incorporated child-protective provisions including the 10-fold safety factor.[11]

The broader insight reflected in the NAS report, that children were inadequately considered in regulatory decision-making and that child-protective policies would ultimately improve the health of people of all age groups, informed and invigorated the Clinton administration's focus on CEH and its promotion within the EPA.[9] Administrator Carol Browner directed the EPA in 1995 through the Policy on Evaluating Risk to Children to "consistently and explicitly consider" the adverse effects of chemicals and other toxicants on infants and children when conducting risk assessments and setting regulatory standards.[12] In 1996, the agency published the National Agenda to Protect Children's Health From Environmental Threats, prioritizing protecting children in environmental standard setting, addressing gaps in research and public education, and calling for sufficient funding to meet these goals.[13]

The initiative expanded to the entire federal government when, in 1997, President Clinton issued Executive Order 13045 making it a "high priority" for all federal agencies to "identify, and address through policies, disproportionate environmental and safety risks to children."[14(p19885)] The order also established a President's Task Force on Environmental Health Risks and Safety Risks to Children to coordinate action across the federal government.[14]

The EPA established the Office of Children's Health Protection (OCHP) in May 1997[15] to integrate this new focus on children into regulatory decision-making and to advocate consideration of CEH in science, programs, and policy. In 1997, OCHP formed the Children's Health Protection Advisory Committee (CHPAC), a federal advisory board, to provide direction to the agency.[16]

Since the 1990s, 3 federal statutes have required specific consideration of CEH in standard setting: the Food Quality Protection Act (1996),[11] the Safe Drinking Water Act Amendments of 1996,[17] and the amended Toxic Substances Control Act (2016).[18] Regulatory standards that have explicitly taken CEH into account include the National Ambient Air Quality Standards for lead (2008),[19] the Mercury and Air Toxics Standard (2012),[20] and the Clean Power Plan (2015), among others.[21]

Despite these advances, achieving the mandate outlined during the Clinton administration has remained elusive. Since its establishment, OCHP has had a relatively small budget and few staff as well as leadership challenges. Both the Government Accountability Office (GAO) and the EPA's Office of Inspector General have at times criticized OCHP for lacking a strategic plan to measurably advance the 1996 National Agenda.[22–25] White House support for CEH has fluctuated. For many years during the George W. Bush administration, the Office lacked a permanent director, and, in 2005, this administration allowed the President's Task Force to expire, leaving the EPA without "a high-level infrastructure or mandate to coordinate federal strategies for children's environmental health and safety."[26(p19)] Under the Obama administration, there was more emphasis on working across the EPA to integrate CEH concerns into regulations, and OCHP staff perceived top-down support, particularly from Administrator Lisa Jackson (Environmental Data and Governance Initiative, confidential oral online interview with EPA employee, February 29, 2020). Though progress has been uneven, the institutionalization of CEH at the EPA has helped to advance research and policy (Table 1).[27]

CHANGES UNDER THE TRUMP ADMINISTRATION

Under the Trump administration, the EPA was at risk for regulatory capture facilitated by political appointees, many of whom had strong ties to regulated industries.[28,29] The agency experienced a flat budget, loss of staff,[30] suppression of scientific expertise,[31] declines in enforcement,[32,33] and reversal of Obama-era health protections.[34] These and other actions undercut the EPA's general ability to carry out its mission, and CEH was also specifically targeted.

The administration undermined CEH by removing leadership, cutting staff and budget, excluding the Office from regulatory and other decision-making, defunding the Children's Centers (CEH research centers), rescinding or weakening rules that were written in part to protect children's health, and sidelining the CHPAC.

LEADERSHIP, BUDGET AND STAFFING, AND INFLUENCE OF OCHP

Under the Trump administration, the OCHP was weakened by removing its leadership, cutting it out of important agency decisions, and exercising control over its external communications and through policy decisions that weaken protection of children.

For example, in September 2018, Ruth Etzel, MD, PhD, OCHP's director, was abruptly removed from her position, contributing to turmoil for some remaining staff (Environmental Data and Governance Initiative, confidential oral online interview with EPA employee, February 29, 2020). At the time of Etzel's removal, OCHP was leading an update of the federal government's lead strategy, which had not been revised in almost 2 decades. The previous federal plan focused on preventing children's exposure to lead paint.[35] The new plan, under Etzel's leadership, would address lead paint, and staff were also considering how to better regulate drinking water, aviation gas (a significant source of lead in air near certain airports),[36] and food. The goal of the updated plan was to create a blueprint for removing lead from children's environments and eliminating childhood lead poisoning (Environmental Data and Governance Initiative, confidential oral in-person interview with EPA employee, May 4, 2019).

After Etzel was placed on administrative leave, the EPA released the final version of the plan in December 2018, which did not include regulatory initiatives that OCHP and children's health advocates recommended, including EPA action on aviation gas, a stronger lead service line replacement program, and a more protective lead in drinking water standard.

Funding and staffing for the OCHP also decreased under the Trump administration. Each year, presidential budget proposals sought cuts that would reduce OCHP's budget by more than half. By contrast, Presidents Bush and Obama proposed budgets for OCHP that were close to, or higher than, what Congress allocated.[37,38] While Congress rejected the drastic cuts proposed by Trump, in inflation-adjusted dollars, OCHP's FY 2020 budget is the lowest budget on record since the EPA organized the current version of the office in 2005 (Table 2). In President Obama's second term, OCHP reached an all-time staffing high, equivalent to about 22 full-time staff. By the end of the Trump administration, that had been cut by 9, a reduction of 40% (Angela Hackel, EPA Office of Public Affairs, e-mail communication, November 19, 2020).[38]

In addition to this erosion of resources, under the Trump administration, OCHP lost influence it had on EPA decisions that could have a significant impact on CEH, as well as established avenues of outreach to the public. For example, OCHP was not consulted on allowing continued use of chlorpyrifos on food or the decision to defund the Children's Health Research Centers. During the Trump administration, the Office lost control of the content of its Web sites to the Office of Public Affairs (Environmental Data and Governance Initiative, confidential oral in-person interview with EPA employee, January 18, 2020) and in a break from past ways of working, the same office led the publication of a 2019 report "Protecting Children's Health,"[39] bypassing OCHP content experts (Environmental Data and Governance Initiative, confidential oral in-person interview with EPA employee, January 18, 2019). The report highlighted OCHP accomplishments from past administrations, such as work on school siting. As one interviewee told us, under the Trump administration "there [was] this effort to make it appear that the office is engaged in things when, in fact, they're not" (Environmental Data and Governance Initiative, confidential oral in-person interview with EPA employee, January 18, 2020).

CHILDREN'S HEALTH CONCERNS IN AGENCY RULES

Congress amended the Toxic Substances Control Act (TSCA) in 2016 after widespread recognition that the old law had too many loopholes. It allowed tens of thousands of chemicals to be on the

TABLE 1— Key Children's Environmental Health Milestones, Accomplishments, and Setbacks Relevant to Environmental Protection Agency (EPA) and Office of Children's Health Protection (OCHP)

Year	Milestone, Accomplishment, or Setback	Description
1993	National Academy of Sciences publishes *Pesticides in the Diets of Infants and Children*: https://www.nap.edu/catalog/2126/pesticides-in-the-diets-of-infants-and-children	Finds children's unique vulnerabilities are not accounted for in pesticide regulation. Recommends more precautionary approach to protect infants and children.
1995	EPA institutes Policy on Evaluating Health Risks to Children: https://www.epa.gov/children/epas-policy-evaluating-risk-children	Directs EPA to "consider the risks to infants and children consistently and explicitly as a part of risk assessments generated during its decision-making process, including the setting of standards to protect public health and the environment."
1996	EPA publishes National Agenda to Protect Children's Health From Environmental Threats: https://www.epa.gov/children/epas-national-agenda-protect-childrens-health-environmental-threats	Seven-point agenda for improving CEH covers standard setting, research, science, policy, education, community right to know, parental responsibility, and funding.
1996	Congresses passes Food Quality Protection Act: https://www.congress.gov/bill/104th-congress/house-bill/1627	Requires consideration of special risks faced by infants and children's health in pesticide regulation and applying a 10-fold protection factor in certain situations.
1996	Congress amends the Safe Drinking Water Act: https://www.govinfo.gov/content/pkg/CPRT-106SPRT67528/pdf/CPRT-106SPRT67528.pdf	Requires consideration of susceptible populations such as infants, children, and pregnant women in regulating drinking water contaminants.
1997 (Apr)	President Clinton issues Executive Order 13045, Protection of Children From Environmental Health Risks and Safety Risks: https://www.epa.gov/children/executive-order-13045-protection-children-environmental-health-risks-and-safety-risks	Directs that federal agencies "(a) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and (b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks." Establishes the Presidential Task Force on Environmental Health Risks and Safety Risks to Children for a period of 4 years.
1997 (May)	EPA establishes the OCHP: https://www.epa.gov/aboutepa/about-office-childrens-health-protection-ochp	EPA's office for implementing national agenda and coordinating efforts to improve CEH.
1997	EPA establishes the Children's Health Protection Advisory Committee: https://www.epa.gov/children/chpac	Federal advisory committee that advises the EPA administrator on CEH policy, research, and risk communication from a diversity of perspectives.
1998	EPA publishes EPA's Rule Writer's Guide to Executive Order 13045: https://cfpub.epa.gov/oarwebadmin/sipman/sipman/mAppContent.cfm?chap=99&OtherFile=appendix/eo13045&RequestTimeOut=500	Provides guidance to rule writers on implementing CEH concerns into regulatory development.
1998	EPA and National Institute of Environmental Health Sciences jointly fund Children's Health Protection Research Centers: https://www.epa.gov/research-grants/niehsepa-childrens-environmental-health-and-disease-prevention-research-centers	Eight centers receive funding in 1998 to study environmental exposures and health outcomes relevant to pregnant women, infants, and children.
1998	Agency for Toxic Substances and Disease Registry and EPA establish the Pediatric Environmental Health Specialty Units: https://www.pehsu.net/About_PEHSU.html	Program to develop and apply clinical and public health expertise in CEH at 10 regional centers throughout the United States.
2000	EPA publishes "Strategy for Research on Environmental Risks to Children": https://www.federalregister.gov/documents/2000/12/12/00-31619/strategy-for-research-on-environmental-risks-to-children	Strategy focused on improving consideration of children in risk assessment and communication and reducing risk from indoor environments.
2000	EPA publishes first edition of "America's Children and the Environment": https://www.epa.gov/americaschildrenenvironment/publications	Report presents data on CEH indicators at a national level such as blood lead levels, asthma prevalence, and children living in areas with significant outdoor air pollution. Updates published in 2003, 2013, and 2019.
2004	EPA inspector general publishes "The Effectiveness of the Office of Children's Health Protection Cannot Yet Be Determined Quantitatively": https://www.epa.gov/sites/production/files/2015-12/documents/20040517-2004-p-00016.pdf	Finds that "OCHP has no formal mechanism in place to ensure performance results or assess the relationships between program costs, activities, and results. . . . data and information systems are not available to measure, analyze, and demonstrate overall performance specific to National Agenda on a continuing basis."
2005	Presidential Task Force provision of Executive Order 13045 expires: https://www.gao.gov/assets/gao-10-205.pdf, p. 41–42	GAO notes: "EPA and the Department of Health and Human Services no longer have a high-level infrastructure or mandate to coordinate federal strategies for children's environmental health and safety."

Continued

TABLE 1— Continued

Year	Milestone, Accomplishment, or Setback	Description
2005	EPA publishes “Supplemental Guidance for Assessing Susceptibility to Early-Life Exposures to Carcinogens”: https://www.epa.gov/sites/production/files/2013-09/documents/childrens_supplement_final.pdf	Recommends using “adjustment factors” when assessing early life risk from mutagens.
2006	EPA publishes “EPA’s Action Development Process: Guide to Considering Children’s Health When Developing EPA Actions”: https://www.epa.gov/sites/production/files/2014-05/documents/epa_adp_guide_childrenhealth.pdf	Provides direction to EPA policymakers for considering CEH in agency rule-making.
2008	EPA publishes “Child-Specific Exposure Factors Handbook”: https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=199243	Provides information on child-specific exposure factors to inform risk assessment.
2010 (Jan)	GAO publishes “High-Level Strategy and Leadership Needed to Continue Progress Toward Protecting Children From Environmental Threats”: https://www.gao.gov/assets/gao-10-205.pdf	Finds that EPA has put less emphasis on CEH in recent strategic plans, the Office did not have a permanent director from 2002 to 2008, and its “effectiveness . . . has declined in the absence of direct and meaningful support from EPA’s Administrator.”
2010 (Feb)	EPA Administrator Lisa Jackson writes memo, EPA’s Leadership in Children’s Environmental Health: https://www.epa.gov/sites/production/files/2015-03/documents/epas_leadership_in_childrens_environmental_health_memo.pdf	Discusses 3 areas of focus on science and regulation, “safe chemicals management,” projects and programs at the community, and national and international levels.
2010 (Apr)	EPA Inspector General publishes “Need Continues for a Strategic Plan to Protect Children’s Health”: https://www.epa.gov/office-inspector-general/report-need-continues-strategic-plan-protect-childrens-health	Finds that EPA did not implement “agreed to corrective actions” for improving strategic planning related to CEH. The Office’s “lack of strategic planning, identified goals, adequate measures, and quantifiable accomplishments result in its inability to demonstrate its role and value added to the protection of children’s health.”
2012	Presidential Task Force publishes “Coordinated Federal Action Plan to Reduce Racial and Ethnic Asthma Disparities”: https://ptfceh.niehs.nih.gov/about/assets/files/health_safty_risks_to_children_508.pdf	The Action Plan presents a coordinated strategy across the federal government to reduce asthma disparities and is the Task Force’s first since the 2000 strategy on eliminating childhood lead poisoning.
2013	GAO publishes “EPA Has Made Substantial Progress but Could Improve Processes for Considering Children’s Health”: https://www.gao.gov/assets/gao-13-254.pdf	EPA has reinstated CEH as a top priority in its 2010 Strategic Plan, and “has increased its role to ensure that EPA program offices consider children’s health protection in their regulatory activities.”
2015	EPA publishes “Children’s Environmental Health Research Roadmap”: https://www.epa.gov/sites/production/files/2015-11/documents/researchroadmap_ceh_508.pdf	Highlights need to make CEH data more accessible and integrated, further understand the environmental contributions to childhood disease, improve understanding of exposure factors, further develop “methods and models to evaluate early life-stage specific risks” and translational research.
2016	US Congress passes Frank R. Lautenberg Chemical Safety for the 21st Century Act: https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/frank-r-lautenberg-chemical-safety-21st-century-act	Requires consideration of risks to pregnant women, infants, and children in evaluating safety and regulating chemicals.
2019	EPA defunds Children’s Environmental Health and Research Centers: https://www.nature.com/articles/d41586-019-01491-1?fbclid=IwAR02CO1fm6jt_wThq7rqqmSP41pcFVK-TT2xIwvQ0U8Pamtwsm7vhjqzRNA	EPA funding is withdrawn from the 13 operating Children’s Research Centers.

Note. CEH = children’s environmental health; GAO = Government Accountability Office.

market whose safety had not been demonstrated, and it did not require that chemicals be regulated to protect CEH.[40] Amended TSCA (the Frank Lautenberg Chemical Safety for the 21st Century Act), emphasizes consideration of susceptible subpopulations, including pregnant women, infants, and children, when making determinations of chemical safety.[18]

At the end of the Obama administration, the EPA published 1 of 3 key rules for amended TSCA implementation, which considers the scope of the assessment of a chemical’s risk to human health. The Obama rule aligned with the intent of amended TSCA, stating that assessments “will evaluate effects at life stage(s) most appropriate for a receptor target.”[41(p7571)] In addition, it broadened the definition of susceptible populations to require consideration of any group at greater risk including infants, children, and pregnant women. It further clarified that susceptible subpopulations could be identified on the basis of “intrinsic (e.g., life stage, reproductive status, age, gender, genetic traits) and acquired (e.g., pre-existing disease, geography,

TABLE 2— Environmental Protection Agency Children's Health Budget (in Millions, 2020 Dollars) and Workforce (in Full Time Equivalents [FTEs])

President	Fiscal Year	President's Budget, $	Enacted Budget, $	Budget Difference, $	President's FTE	Enacted FTE	FTE Difference
Bush	2005	9.4	7.9	1.5	16	No data	NA
Bush	2006	8.8	7.2	1.6	15.9	12.9	3.0
Bush	2007	7.6	7.5	0.1	15.9	13.9	2.0
Bush	2008	7.5	7.4	0.1	13.9	11.9	2.0
Bush	2009	7.6	7.3	0.3	13.9	11.9	2.0
Obama	2010	7.7	8.4	–0.7	11.9	11.9	0.0
Obama	2011	11.7	8.2	3.5	25.9	11.9	14.0
Obama	2012	12.2	8.4	3.7	30.9	18.2	12.7
Obama	2013	12.1	8.4	3.7	30.9	18.2	12.7
Obama	2014	9.3	7.2	2.1	25.0	22.0	3.0
Obama	2015	8.8	7.2	1.7	21.8	21.8	0.0
Obama	2016	8.7	7.1	1.6	21.8	21.8	0.0
Obama	2017	8.3	6.9	1.4	21.8	21.8	0.0
Trump	2018	2.1	6.7	–4.6	6.9	21.8	−14.9
Trump	2019	2.0	6.6	–4.6	6.9	19.6	−12.7
Trump	2020	2.5	6.2	–3.6	9.9	18.4	−8.5
Trump	2021[a]	2.7	6.2	−3.5	9.9	18.4	−8.5

[a] Staffing in fiscal year 2021 was 13 FTE (Angela Hackel, EPA Office of Public Affairs, e-mail communication, November 19, 2020).

socioeconomic, cultural, workplace)" characteristics.[41(p7568)]

The Trump administration, however, rewrote this rule to align with the preferences of the American Chemistry Council, an industry trade group for chemical manufacturers. Nancy Beck, formerly of the American Chemistry Council, led the rewrite as the deputy assistant administrator of the Office of Chemical Safety and Pollution Prevention.[42]

Published in July 2017, the final version softened the requirement for comprehensive evaluation of a chemical's harms, making it less prescriptive of children's health protections. The Obama administration's language that risk evaluations "*will* evaluate effects at life stage(s) most appropriate for a receptor target [emphasis added]"[41(p7571)] was changed to "*may* evaluate [emphasis added]."[43(p33742)] The Obama EPA's expanded definition of susceptible populations was also removed from the final rule.[43]

The agency's risk evaluation of trichlorethylene, conducted under amended TSCA, which relies on immune system effects, rather than the more sensitive fetal heart defects endpoint, illustrates how the Trump administration's EPA has implemented the Chemical Risk Evaluation rule to ignore important risks to children (Environmental Protection Agency, Office of Chemical Safety and Pollution Prevention, Draft Risk Evaluation for Trichloroethylene, February 2020).[44]

DEFUNDING CHILDREN'S CENTERS' RESEARCH

Science is vital to the federal commitment to CEH because strengthening regulatory standards to protect children requires a firm evidentiary base. Scientific research is the second point in EPA's 1996 National Agenda.[13] In the late 1990s, there were many research gaps, and few prospective cohort studies on infants or children had been conducted, outside of several that focused on lead, mercury, and polychlorinated biphenyls (PCBs).[45] There was a clear need for such studies to examine environmental exposures across developmental stages from prepregnancy through adolescence, and better measurement techniques to more accurately characterize exposures.[46]

In 1998, the National Institute of Environmental Health Sciences (NIEHS) and EPA began jointly funding the Centers for Children's Environmental Health and Disease Prevention Research. The first year, 8 centers were funded, and, by 2017, there were 13 centers at major research institutions focused on a wide range of exposures and effects.[47]

To address community concerns about equity, influence, and ownership of research, some Centers employed a community-based participatory research approach, partnering with communities throughout the research process. Many Centers focused on disproportionately exposed communities who have been frequently left out of research such as low-income children, children of color, and children of farmworkers. Centers were also required to conduct community outreach and education.[48]

Children's Centers pioneered methodological advances, addressing some of the key challenges of epidemiological studies, developing new ways to more accurately measure exposure, shedding light on gene–environment interactions, and developing biomarkers to "see" disease processes at earlier stages and to understand how environmental toxicants might disrupt normal biological processes.[47]

The EPA also required that Center research foci were tied to agency statutory responsibilities.[48] Center research has been cited in numerous federal and state regulatory decisions.[47] There is no similar network of CEH research centers anywhere in the world.

The Columbia University Children's Center's research on chlorpyrifos exposure in utero and its effects on neurodevelopment[49,50] informed the Obama EPA's decision to revoke food tolerances for chlorpyrifos. The Trump administration reversed that decision and was applauded by chemical and agricultural interests, who pushed for more concessions on regulation of organophosphate chemicals (J. Collins, CropLife America e-mail to Nancy Beck, in author's possession obtained through the Freedom of Information Act, April 9, 2018). The threat these research centers represented to industry may have prompted Trump's EPA to withdraw funding[51] leaving the NIEHS unable to fund the Centers on its own.

RESCINDING OR WEAKENING PROTECTIVE REGULATIONS

The Trump administration challenged or reversed many regulations that affect CEH, including some that focused explicitly on CEH as part of their regulatory rationales. One of the most significant was the Clean Power Plan (2015) aimed at reducing carbon dioxide emissions from power plants. The Clean Power Plan noted that children are "particularly vulnerable to climate change," and at risk from health effects related to "heat waves, air pollution, infectious and waterborne illnesses," and "mental health effects resulting from extreme weather events."[52(p64683)]

Other agency actions under Trump that affected CEH include the agency's weakening of the Mercury and Air Toxics rule (2012)[53] and determinations to not strengthen National Ambient Air Quality Standards for ozone and particulate matter of 2.5 micrometers or smaller ($PM_{2.5}$).[54,55] Ozone exposure at low levels is linked to breathing problems and asthma,[56] and $PM_{2.5}$ exposure is increasingly linked with adverse effects on children's brain development.[57]

SIDELINING THE ADVISORY COMMITTEE

Under the Trump administration, EPA leadership also undercut CEH by sidelining the CHPAC. CHPAC advises the agency from policy, advocacy, legal, and scientific perspectives. The EPA submits specific questions to CHPAC, and the committee's responses are recorded in formal comment letters.

Under Obama, CHPAC formally commented on agency rule-making or policies 23 times (3 times per year) on topics such as the National Ambient Air Quality Standards for ozone, prenatal exposures, school siting, and chemicals of concern for children.[58]

In 2017, the CHPAC wrote 3 response letters, at least 1 of which was initiated under the Obama administration (Protecting Children's Health Under Amended TSCA). In 2018 and 2019, they did not respond to any charge questions; presumably they were given none. In 2020, they provided 1 response letter on risk communication[58] and were charged with 2 questions to be answered in 2020, (TSCA Workplan Chemicals and "EPA's role in protecting children from environmental exposures in school and child care").[59]

Compared with during the Obama administration, the committee was underutilized, and its role circumscribed.

CONCLUSIONS AND RECOMMENDATIONS

Since the 1990s, the EPA has recognized the importance of CEH and has institutionalized a modest program to address environmental health risks disproportionately affecting infants and children. The Trump administration substantially limited the EPA's ability to move the CEH agenda forward. Key science was halted, the agency rolled back significant regulations that would have improved CEH, and, except for court-ordered lead hazard and clearance standards,[60] we are not aware of any new EPA regulations or standards issued under the Trump administration that would reduce children's exposure to environmental toxicants. What's more, its deregulatory initiatives allow for ongoing or even increased harm.

However, even before the Trump administration, CEH faced longstanding challenges at the EPA, including lack of prioritization, limited resources, inadequate strategic planning, and long periods of time without a director. Another key challenge has been structural in that, although OCHP is "responsible for implementing the [1996] National Agenda it is not directly responsible for many of the goals outlined in the National Agenda."[23(p4)]

To improve CEH prioritization at EPA, it is important to learn from Trump administration actions and earlier critiques of CEH activities at the EPA. It is also important to recall the important reasons the CEH program and focus was implemented at the EPA in the first place: to ensure that the most vulnerable are protected from environmental harm and, thereby, also improve the health of people across all age groups.

To increase prioritization, integration with parallel efforts, and accountability for CEH, we offer recommendations based on our research and previous reviews of EPA's CEH work. Successful follow-through on these recommendations also depends on restoration and reinvigoration of the EPA itself, which we and others have discussed elsewhere.[5,61]

- *Examine the need for a federal CEH protection statute.* Many environmental statutes were written in the 1970s, before the expansion of research on and understanding of children's unique vulnerabilities to environmental harms. While some statutes have been updated to include specific consideration of CEH, a comprehensive, authoritative review of federal environmental statutes and their application to determine the extent to which they are protective of fetuses, infants, and children should be conducted. Such a review should address whether Executive Order 13045—which applies to "economically significant rules," those with an economic impact of $100 million or greater[62(p7)]—and other elements of EPA's regulatory framework are sufficient to ensure protection from environmental harm or whether there are gaps that should be remedied.
- *Ensure that EPA administrators support and prioritize CEH and appoint competent leadership to the OCHP.* This is critical for advancing a CEH perspective within the federal government and in EPA program offices. Administrative prioritization should be strongly reflected in the EPA's strategic plan.[63] There should be a robust system of accountability for ensuring that program offices are addressing CEH and collaborating with OCHP, including building this into performance reviews of relevant leadership and staff.
- *Further integrate CEH concerns into EPA rulemaking.* Particularly during the Obama administration, OCHP had made progress on ensuring CEH issues were being taken into account in agency rulemaking.[22] This should be restored and reinvigorated, with mechanisms added to better ensure accountability. Crafting rules and regulations to be protective of CEH is likely to have the most significant impact on health over the long term. Significant guidance documents should be reviewed and updated to prioritize CEH—for example, revising the TSCA risk evaluation rule discussed earlier should be a high priority. Refocusing the federal lead strategy on primary prevention is also critical.
- *Update the 1996 National Agenda and Administrator Jackson's 2010 priorities*[64] *to ensure that these guiding documents encompass the totality of CEH issues that EPA and OCHP should be addressing.* Some notable absences are climate change, enforcement, and environmental justice. Once the agency's overarching priorities for CEH are clarified and updated, an implementation strategy is needed with measurable goals and accountability. EPA recently updated its 1995 Policy on Evaluating Health Risks to Children to include a broader statement about considering CEH in human health decision-making, and an updated rationale for doing so that highlights underserved communities and climate change.[65]
- *Increase funding and personnel in OCHP.* The Office's historically low levels of funding and staff require redress. More funding and personnel could enable the Office to lead more cross-federal agency initiatives and cross-program initiatives within the EPA (like the federal lead strategy); strengthen the integration of children's health concerns into rule development, compliance, and enforcement; and detail OCHP staff to program offices (e.g., Air, Water, Superfund, Pesticides, Environmental Justice) to improve collaboration. An expanded OCHP could also develop a core staff dedicated to children's health dimensions of climate change both in terms of mitigation and adaptation.

- *Improve data systems to identify and monitor CEH issues.* America's Children and the Environment's indicators[66] could be augmented to address current concerns at varying levels of geography—in particular, climate change indicators like extreme heat, wildfire smoke, and vector-borne illness, as well as relevant CEH enforcement indicators. Alternatively, the EPA could combine America's Children and the Environment's indicators with the Centers for Disease Control and Prevention's Environmental and Public Health tracking tool, which has a Web-based interface and data visualizations.[67] Timelier as well as small-area data should be priorities.
- *Prioritize issues at the intersection of CEH and environmental justice.* The Office of Environmental Justice and OCHP, though appropriately distinct offices, should prioritize working together on actions in which CEH and environmental justice concerns converge—for instance, speeding up lead service line replacements in overburdened environmental justice communities. The agency's compliance and enforcement priorities should also focus on where CEH and environmental justice intersect—for example, improving compliance with the Lead Based Paint Renovation and Repair rule.[68] EPA's Office of Enforcement and Compliance Assurance could develop a National Compliance Initiative that addresses the top environmental justice threats to CEH.
- *Strengthen the CHPAC and ensure this body's expert advice informs agency decision-making.* Furthermore, decisions on which topics the CHPAC should weigh in on should not be controlled by political appointees but by content experts in OCHP and other program offices.
- *Restore and increase EPA funding for CEH research, and particularly for prospective cohort studies focused on toxicants of regulatory interest and ethically designed intervention studies that increase knowledge of strategies to protect children from multiple and interacting environmental stressors.* The Children's Health Research Centers were an effective model for observational research. While there is other federal funding for CEH research, it is important that the EPA funds research that aligns with and informs its statutory responsibilities as well as environmental justice concerns.

The Trump administration has damaged our system of protecting human health and the environment, but earlier administrations also struggled to incorporate CEH into environmental governance. Rather than returning to the status quo, the goal should be to build more equitable and effective governance of environmental threats to our children's health. The leadership of the country and the EPA should not only repair the damage but also prioritize CEH to an extent that has not yet been accomplished. Protecting our most vulnerable populations from environmental harm today and ensuring a habitable planet for tomorrow will require moving children's health and environmental justice from the margins to the center of the EPA's work.

ABOUT THE AUTHORS

Marianne Sullivan is with the Department of Public Health, William Paterson University, Wayne, NJ. Leif Fredrickson is with the Department of History, University of Montana, Missoula. Chris Sellers is with the Department of History, Stony Brook University, Stony Brook, NY.

CORRESPONDENCE

Correspondence should be sent to Marianne Sullivan, DrPH, Department of Public Health, 368 University Hall, William Paterson University, Wayne, NJ 07470 (e-mail: sullivanm19@wpunj.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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The authors have no conflicts of interest to report.

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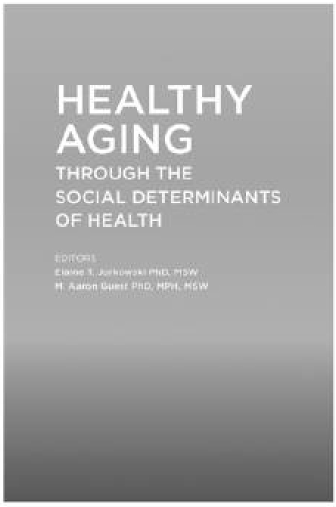

Inequities in *Chlamydia trachomatis* Screening Between Black and White Adolescents in a Large Pediatric Primary Care Network, 2015–2019

Sarah Wood, MD, MSHP, Jungwon Min, PhD, Vicky Tam, MA, Julia Pickel, BA, Danielle Petsis, MPH, and Kenisha Campbell, MD, MPH

See also Pickett et al., p. 7.

Objectives. To identify associations between patient race and annual chlamydia screening among adolescent females.

Methods. We performed a retrospective cohort study of females aged 15 to 19 years in a 31-clinic pediatric primary care network in Pennsylvania and New Jersey from 2015 through 2019. Using mixed-effect logistic regressions, we estimated associations between annual chlamydia screening and patient (race/ethnicity, age, previous chlamydia screening and infection, insurance type) and clinic (size, setting) characteristics. We decomposed potential effects of clinician's implicit racial bias and screening, using covariates measuring the proportion of Black patients in each clinician's practice.

Results. There were 68 935 well visits among 37 817 females, who were 28.8% Black and 25.8% Medicaid insured. The mean annual chlamydia screening rate was 11.1%. Black females had higher odds of screening (adjusted odds ratio [AOR] = 1.67; 95% confidence interval [CI] = 1.51, 1.84) than did White females. In the clinician characteristics model, individual clinicians were more likely to screen their Black versus non-Black patients (AOR = 1.88; 95% CI = 1.65, 2.15).

Conclusions. Racial bias may affect screening practices and should be addressed in future interventions, given the critical need to increase population-level chlamydia screening. (*Am J Public Health*. 2022;112(1):135–143. https://doi.org/10.2105/AJPH.2021.306498)

In the United States, 2019 marked the sixth consecutive year of increasing rates of sexually transmitted infections (STIs).[1] *Chlamydia trachomatis*, the most commonly reported bacterial disease in the United States, now has the highest prevalence ever recorded.[1] Nearly half of infections occurred in individuals aged 15 to 24 years.[2,3] Chlamydia infections can significantly affect quality of life and morbidity across the lifespan. Untreated chlamydia in females may lead to pelvic inflammatory disease (PID) and result in chronic pelvic pain, infertility, ectopic pregnancy, and increased susceptibility to HIV infection.[4,5] Recent Centers for Disease Control and Prevention (CDC) analyses estimate that chlamydia in those aged 15 to 24 years accounted for approximately $452 000 000 in direct lifetime medical costs.[6]

Routine population-based screening is a key strategy to reduce the morbidity and transmission of chlamydia. The CDC, the US Preventive Services Task Force (USPSTF), and the American Academy of Pediatrics (AAP) recommend annual screening of sexually active cisgender females aged 15 to 26 years.[7–9] Routine screening can lead to early identification and treatment of asymptomatic infections, thereby lowering the risk of forward transmission and PID.[10] Screening also introduces a golden opportunity for clinicians to counsel adolescents regarding comprehensive sexual health, such as STI and HIV prevention, contraception, and healthy communication in relationships—all practices strongly recommended in preventative health guidelines.[11,12]

Unfortunately, the application of these screening guidelines has been far from universal in pediatric practices.[13–17] Despite clinical practice guidelines, rates of chlamydia screening in pediatric care settings are both suboptimal and often inequitable.[17] Previous research demonstrates higher lifetime risk of chlamydia and PID among Black females than among their White counterparts.[18–20] However, it is unclear whether the higher burden of infection is attributable to increased prevalence alone or is exacerbated by clinician implicit bias. Implicit bias, defined as associations existing outside conscious awareness that may negatively influence clinician behavior and treatment choices,[21] may lead to higher screening rates in Black females. The extent to which implicit bias could contribute to disproportionate screening, and thus detection of early asymptomatic infection, in Black and Latinx females is currently unknown.[22,23] Population estimates of lifetime sexual activity for adolescent females across racial and ethnic groups are nearly equivalent (38% for White, 42% for Latinx, and 42% for Black female high school students) and do not justify differential screening practices in pediatric care settings.[24]

To improve routine chlamydia screening for all adolescents, there is a critical need to elucidate and ameliorate the drivers of inequitable screening practices. As national chlamydia prevalence continues to increase, understanding targets for interventions to improve universal screening of sexually active young women is a key public health task. Although previous analyses have identified higher rates of screening of Black women,[17,22] it is unclear whether these clinician effects are attributable to between-clinician effects (wherein clinicians with robust screening practices may also care for a higher proportion of Black patients) or in-clinician effects (wherein implicit bias may drive individual clinicians to disproportionately screen their Black, rather than White, patients).

We assessed variability in annual chlamydia screening rates across a large and geographically diverse pediatric primary care network and determined the influence of patient race and ethnicity on screening outcomes at the patient, clinic, and individual clinician levels.

METHODS

This retrospective cohort study included females aged 15 to 19 years receiving primary care services in a 31-practice academic, pediatric, primary care network serving approximately 250 000 patients annually across urban and suburban Pennsylvania and New Jersey. Two of the urban practices receive federal Title X family-planning funding and provide additional adolescent confidential family-planning services, such as free contraception and HIV testing, in addition to routine primary care. The other 29 sites are standard pediatric primary care offices.

We included patients if they were assigned female sex at birth and attended an annual well visit during the study period of July 2015 through December 2019. We collected relevant screening data from Qlik (Radnor, PA), a commercial business intelligence platform. As part of a chlamydia screening quality improvement initiative, Qlik captured chlamydia screening data from well visits for all females aged 15 to 19 years since 2014, including screening status (screened vs not screened), demographic characteristics, clinic site, and well visit clinician.

Measures

Our outcome measure was receipt of chlamydia screening by nucleic acid amplification test (urine, vaginal, or cervical swab) in an annual well visit year, defined as the 364 days before and on the day of the annual well visit. We used the year-long measure to account for chlamydia screening that was asynchronous with the annual well visit but still fulfilled the annual screening recommendations on the day of the annual well visit. We classified individuals (n = 478) who had chlamydia screening outside the annual well visit year (i.e., in a previous 365-day period if a well visit did not occur) as not screened at their annual well visit. We determined patient- and clinic-level exposures based on previous literature documenting their potential influence on chlamydia screening.[17,19,20,22]

Patient Characteristics

We collected race and ethnicity by patient report or registrar assessment at visit registration; therefore, race should be interpreted as “observed race.” We calculated age as age in years at the time of visit. Sexual history is not captured as a discrete variable in the electronic health record system, and previous studies have demonstrated that proxy metrics of sexual activity (e.g., Healthcare Effectiveness Data and Information Set criteria) perform poorly in pediatric data.[25,26] Thus, we used previous receipt of chlamydia screening and, separately, previous chlamydia infection as proxy metrics for sexual activity and chlamydia risk. We categorized insurance as public (Medicaid), private, none, or missing.

Clinic Characteristics

We estimated clinic size by the total number of unique clinicians over the study period and categorized them as less than 10, 10 to 19, or 20 or more clinicians. We categorized clinic setting as Title X urban, non-Title X urban, or suburban to account for collinearity between geography and Title X funding status. We derived the adolescent patient proportion (proportion of total clinic volume composed of patients aged 13 years or older) and the proportion of patients privately insured at each clinic from estimates created through Arcus Cohort Discovery (Children's Hospital of Philadelphia, Philadelphia, PA), a proprietary tool that provides aggregate statistics describing the patient population in the source health system.

Clinician Characteristics

We categorized clinicians by training as general pediatricians, residents, adolescent medicine specialists (i.e., attending physicians or fellows), or nurse practitioners. We calculated clinicians' years in practice at the time of each visit by health system data supplemented with National Provider Identification data when needed. The study data set had clinician information only for the day of the annual well visit; therefore, for the clinician characteristics analysis, we excluded visits where chlamydia screening was not ordered at the well visit (i.e., excluding tests ordered in the 364 days before the visit) to avoid falsely attributing the well visit clinician characteristics to chlamydia screening episodes that did not occur synchronously with the well visit. We also excluded visits where the patient was seen by resident physicians (n = 2049) because of collinearity between resident clinician type and clinician years in practice. Clinician age, sex, and race data were not available for analysis.

Statistical Analysis

Descriptive statistics summarized characteristics of patients and clinic sites. We determined annual chlamydia screening rates for each clinic by calculating the proportion of all well visits with a completed chlamydia screening in the annual well visit year. We calculated the mean annual screening rate for the study period by summing the annual screening rates across the network and dividing by 5 (the number of observation years). We determined the clinic-adjusted mean annual screening rate by first calculating the mean annual screening rate at each individual clinic, summing these, and dividing by the 31 clinics in the network. To examine associations between patient and clinic characteristics on chlamydia screening, we used mixed-effects logistic regression models and estimated odds ratios accounting for random effects of patients and clinic sites. We first conducted models assessing associations between patient factors and then separately clinic factors on the chlamydia screening outcome. We were unable to include the clinic proportions of adolescent and insured patients at each clinic in these models because of collinearity with the clinic setting variable. We intended the coefficients for race and ethnicity in the regression analyses to measure the racial/ethnic health inequities that would remain for non-White patients if clinic context and our proxy metrics for sexual activity were standardized across the sample and insurance was set to equal that of the White patient sample.[27] The final multivariable model contained both patient and clinic characteristic factors with a P level of less than .2.

In the clinician characteristics model, we used the combined patient and clinic characteristic multivariable model described, further including clinician training and clinician's years in practice. Given previous data demonstrating higher rates of screening among Black versus White adolescents,[17] we aimed to assess whether patient observed race affected chlamydia screening at the level of the individual clinician. For example, data from individual clinicians who screen a high proportion of patients for chlamydia and also have a high volume of Black patients could erroneously strengthen the association between race and screening across the sample.

To examine whether race-based screening disparities were potentially related to individual clinician implicit bias (in-clinician effect) compared with the proportion of Black patients seen by each clinician (between-clinician effect), we created a parameter presenting the proportion of Black patients in each clinicians' practice (*mblack* = the mean number of encounters with Black patients per clinician). To decompose the in-clinician and the between-clinician components, creating an estimated effect of clinician implicit bias on the odds of chlamydia screening, we created a new "Black" variable that represented the difference between individual patient race (0 = non-Black vs 1 = Black) and the *mblack* parameter (Black = patient race-*mblack*) using methods previously described by Gerber et al.[28]

We conducted all statistical analyses using Stata version 16 (StataCorp, College Station, TX) and SAS version 9.4 (SAS Institute, Cary, NC).

RESULTS

From July 1, 2015, to December 31, 2019, 37 817 females aged 15 to 19 years attended 68 935 annual well visits (37 817 females had 1 visit, 21 028 had 2 visits, 8468 had 3 visits, 1561 had 4 visits, and 61 had 5 visits). The demographic characteristics of patients by chlamydia screening status are displayed in Table 1. Demographic characteristics by each of the 31 clinic sites are displayed in Table A (available as a supplement to the online version of this article at http://www.ajph.org). Patients were 28.8% Black and 25.8% Medicaid insured, with a median age of 15 years (interquartile range = 15–16 years). Over the observation period, 11.3% of patients at well visits had a chlamydia test completed at or in the annual well visit year (Figure 1), translating to 16% (n = 6067) of patients having at least 1 chlamydia test performed during the study period. The mean annual screening rate for the study period was 11.1%, and the rate increased annually (Table B, available as a supplement to the online version of this article at http://www.ajph.org). However, screening rates between the clinics were highly variable. The clinic-adjusted mean annual screening rate was 5.6% (range = 0%–39%). The chlamydia test positivity rate for well visits where screening occurred across the study period was 12.9%, with 1008 infections identified.

In the patient characteristics model, Black race, Latinx ethnicity, older age, having public insurance, having had a previous chlamydia screening, and having had a previous chlamydia infection were all significantly associated with increased odds of screening in an annual well visit year. In the clinic characteristics model, larger clinic size was associated with increased odds of screening, and urban clinics (both Title X and non-Title X) had significantly higher odds of screening. In the combined multilevel patient and clinic model, Black race (adjusted odds ratio [AOR] = 1.67; 95% confidence interval [CI] = 1.51, 1.84) and Latinx ethnicity (AOR = 1.24; 95% CI = 1.07, 1.44) remained significantly associated with odds of chlamydia screening (Table 2).

The clinician characteristics analysis (Table 3), exploring the effects of the Black versus non-Black composition of patients in clinicians' case mix on screening practices as a measurement of implicit racial bias, included 66 401 encounters with 630 unique clinicians. We identified significant associations between patient race (Black vs non-Black) and chlamydia screening (AOR = 1.88; 95% 95 = 1.65, 2.15), indicating that after accounting for the proportion of Black versus non-Black patients in a clinicians' case mix and the other patient and clinic characteristics captured in the first regression model, clinicians remained significantly more likely to screen Black than White female patients, suggesting that implicit bias may play a role in screening decisions.

DISCUSSION

In a geographically diverse regional health care system, we found overall low chlamydia screening rates, high variability in screening practices across clinics, and evidence of inequitable screening practices by patient race and ethnicity. These findings emphasize the need to standardize adherence to chlamydia screening guidelines across health systems and to ensure that screening efforts are applied equitably across patient groups. Although our data were limited by a lack of a standard informatic measure of sexual activity, the 11.1% mean annual chlamydia screening rate across clinics falls far below population estimates of adolescent sexual activity, even among high school freshman.[24] Health systems should adopt and promote standardized guidelines promoting equitable universal chlamydia screening in sexually active young women in accordance with USPSTF, CDC, and AAP guidelines.

Notably, we found that Black and Latinx adolescents had significantly higher odds of screening than did their White peers, after adjusting for markers of sexual activity, including increasing age, previous chlamydia screening, and previous chlamydia diagnosis. In our clinician characteristics analysis examining the impact of race on chlamydia screening practices, adjusting for clinic characteristics and accounting for the race-based case mix of clinicians, evidence of inequitable screening practices persisted, suggesting that racial bias may have influenced screening rates. Although the higher rates of screening among Black adolescents may be seen as a favorable outcome given the role of early detection and treatment of chlamydia in reducing PID, this pattern of differential screening suggests that clinicians may use race in either algorithmic or heuristic assessments of sexual health needs, rather than applying universal screening logic recommended by the AAP, CDC, and USPSTF. A recent analysis of the

TABLE 1— Patient-Level Demographics of the Study Sample Attending Well Visits and Clinical Sites: Pennsylvania and New Jersey, 2015–2019

Characteristic	Never Screened in Preventative Visit Year (n = 31 750; 84.0%), No. (%) or Median (IQR)	Ever Screened in Preventative Visit Year (n = 6067; 16.0%), No. (%) or Median (IQR)	Total n = 37 817, No. (%) or Median (IQR)
Patient characteristics			
Race			
Black	6 895 (21.7)	4 012 (66.2)	10 907 (28.8)
White	19 949 (62.9)	1 457 (24.0)	21 406 (56.6)
Other	4 881 (15.4)	593 (9.8)	5 474 (14.5)
Missing	25 (0.1)	5 (0.1)	30 (0.1)
Ethnicity			
Non-Latinx/missing	29 924 (94.2)	5 741 (94.6)	35 665 (94.3)
Latinx	1 826 (5.8)	326 (5.4)	2 152 (5.7)
Age at well visit, y	15 (15–16)	16 (15–17)	15 (15–16)
No. of well visits in study period	2 (1–2)	2 (1–3)	2 (1–2)
Insurance type			
Uninsured/missing	2 726 (8.6)	700 (11.5)	3 426 (9.1)
Public	6 817 (21.5)	2 952 (48.7)	9 769 (25.8)
Private	22 207 (69.9)	2 415 (39.8)	24 622 (65.1)
Clinic characteristics			
Clinic setting			
Urban Title X	2 419 (7.6)	2 914 (48.0)	5 333 (14.1)
Urban non-Title X	4 108 (12.9)	1 562 (25.8)	5 670 (15.0)
Suburban	25 223 (79.4)	1 591 (26.2)	26 814 (70.9)
Mean no. of clinicians by clinic[a]			
1–9	7 481 (23.6)	392 (6.5)	7 873 (20.8)
10–19	21 154 (66.6)	1 948 (32.1)	23 102 (61.1)
≥ 20	3 115 (9.8)	3 727 (61.4)	6 842 (18.1)
Proportion of privately insured patients by clinic[b]			
< 49%	3 499 (11.2)	3 744 (61.7)	7 243 (19.2)
≥ median, ≥ 50%	28 251 (89.0)	2 323 (38.3)	30 574 (80.8)
Proportion of clinic patients who are adolescents[c]			
< median < 33%	13 237 (41.7)	4 683 (77.2)	17 920 (47.4)
≥ median ≥ 34%	18 513 (58.3)	1 384 (22.8)	19 897 (52.6)

Note. IQR = interquartile range. The sample comprised females aged 15–19 years. The sample size was n = 37 817.

[a] Number of unique clinicians in clinics over the study period.
[b] Proportion of patients in each clinic (entire clinic, not just sample) that were privately insured.
[c] Proportion of patients in each clinic (entire clinic, not just sample) that were adolescents aged 13–18 years.

National Survey of Family Growth demonstrated that Black females were more likely to be asked about sexual activity, offered condoms, and offered STI screening at routine preventative health visits than were their White peers.[29]

The race-based differences in sexual health service delivery observed in our data are consistent with the Institute of Medicine's definition of health inequities: care that has been "differentially allocated on the basis of social class, race, and ethnicity."[30(p123)] These inequities may stem from historical

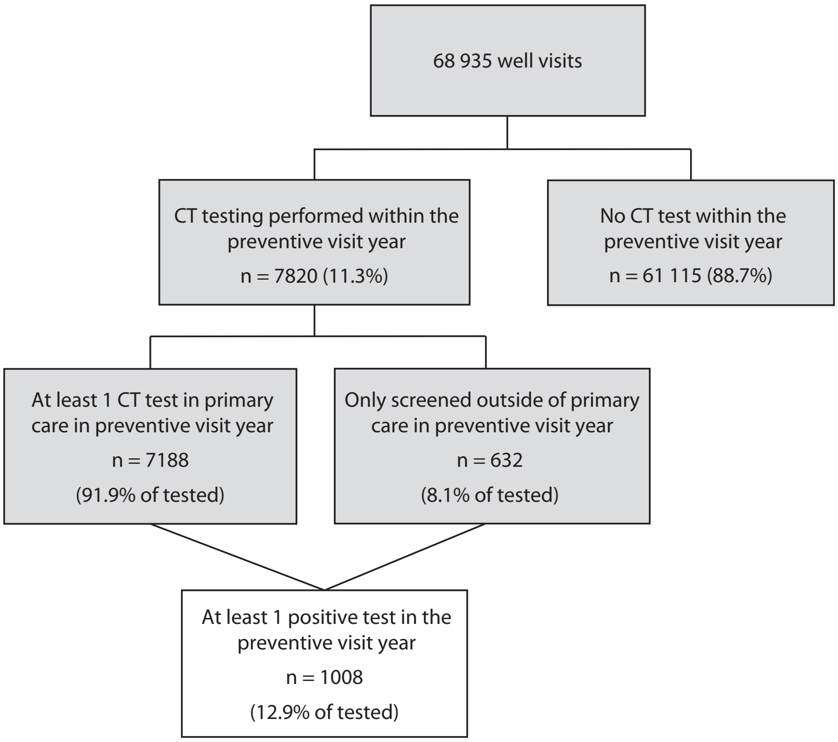

FIGURE 1— Chlamydia Screening Status Across Well Visits by Females Aged 15–19 Years: Pennsylvania and New Jersey Health System-Affiliated Clinics, 2015–2019

Note. CT = *Chlamydia trachomatis.* Preventative care year represents the 365 days before and of the well visit. The sample size was n = 37 817 individuals.

and systemic racism, wherein Black females are sexualized and seen as more likely to engage in "risky" sexual behavior, despite no evidence from national data.[24] Notably, these stereotypes not only may influence which tests clinicians order in a well visit but can also lead to biased conversations on sexual health that further stigmatize and marginalize Black adolescents. Further, although racial bias may have led to disproportionately higher service delivery to Black adolescents in this study, these same biases may lead to undertreatment of acute pain and criminalization of mental health in other clinical settings.[21] For any health outcome and directionality, implicit racial bias is not benign.

It is also possible that the inequitable screening rates by race or ethnicity in our data could be influenced by a clinician's desire to test those "at higher risk" according to population prevalence. Previous epidemiologic studies have consistently reported higher rates of STIs among Black and Latinx females than among their White counterparts.[18,31] However, this logic may create a "chicken or the egg" phenomenon, whereby racial bias drives suboptimal routine screening rates in White females, thus leading to White females contributing to a smaller proportion of the population chlamydia prevalence rates than their Black peers. This trend would lead to biased estimates that then further influence clinician screening practices. Notably, we derived our data from the Philadelphia, Pennsylvania, metropolitan area, which has the third highest STI rates in the nation. Arguably, the entire sample thus had an increased population prevalence of chlamydia.

In a recent *Journal of the American Medical Association* Viewpoint "Addressing Systemic Racism Through Clinical Preventive Service Recommendations From the US Preventive Services Task Force," the authors noted:

> Across clinical preventive services, more evidence is needed to move beyond the current state of merely knowing that certain groups have higher disease prevalence and worse health outcomes to understanding effective evidence-based interventions to improve health outcomes.[32(p628)]

With respect to chlamydia screening, system-wide quality improvement interventions have been successful in improving chlamydia screening rates in adolescent females.[33–37] However, these quality improvement efforts have largely targeted overall screening rates, not the essential task of closing the equity gap in screening practices. Without concerted efforts to target racial bias, improving screening rates in the absence of ensuring equity will not be enough. Without careful attention, these interventions can result in differential effects by race and ethnicity, as well as further distrust of the health care system and the continued emotional trauma of racism.[38]

Interventions that focus on standardizing and automating care delivery may uniquely hold promise for reducing disparities. One such tool is clinical decision support, including electronic nudges or "best practice alerts," which can move clinicians closer to universal screening of sexually active youths. In

TABLE 2— Association of Patient and Clinic Characteristics and Receipt of Chlamydia Screening by Well Visit: Pennsylvania and New Jersey, 2015–2019

Characteristic of Well Visit Patients	AOR (95% CI)
Patient characteristics	
Age	1.23 (1.20, 1.26)
Race/ethnicity	
White (Ref)	1
Black	1.67 (1.51, 1.84)
Other race	1.09 (0.97, 1.22)
Latinx	1.24 (1.07, 1.44)
Insurance	
Public (Ref)	1
Private	0.77 (0.72, 0.83)
Previous chlamydia screening	20.17 (18.53, 21.95)
Previous chlamydia infection	3.84 (2.84, 5.18)
Clinic characteristics	
Clinic size	
< 10 clinicians (Ref)	1
10–20 clinic clinicians	1.77 (0.93, 3.38)
> 20 clinic clinicians	9.56 (1.56, 58.46)
Clinic setting	
Suburban clinics (Ref)	1
Urban Title X	1.74 (0.22, 14.00)
Urban non-Title X	2.29 (1.40, 3.74)

Note. AOR = adjusted odds ratio; CI = confidence interval. The table presents the results of the combined patient and clinic characteristics multilevel mixed-effects regression model. The sample size was n = 68 935 individuals.

addition, there is a need for an accurate and standardized collection of sexual activity data to ensure that pediatricians are screening the right youths at the right time. Lastly, whereas quality improvement efforts to standardize care may lessen disparities, they do not directly address the drivers of the inequities. Clinician training to reduce implicit bias and systemic racism in medicine is a key step toward rooting out the potential underlying causes of these health inequities. There is a critical need for implementation science research to elucidate optimal dissemination of implicit bias training across health systems.

Limitations

Our analyses have limitations. The network's electronic health record system does not have a metric for sexual activity—a common problem in pediatric health systems. Although researchers have proposed algorithms and decision rules for identifying sexually active individuals in health system data, many of these methods perform poorly when applied to adolescent data.[25,26] In our analysis, we instead used proxy markers for sexual activity, including age, previous screening, and previous infection. Importantly, although we were not able to measure sexual activity in our cohort, the mean annual 11% chlamydia screening rate falls far below the 38% of high school females estimated to be sexually active in the most recent Youth Risk Behavioral Surveillance Survey (YRBSS) data.[24]

Additionally, given the minimal differences in sexual activity rates for White versus Black high school students in the YRBSS data, we would not expect differences in sexual activity rates by race to explain our findings. In the available data, we were unable to reliably distinguish asymptomatic screening from symptomatic testing. Without knowledge of symptoms, our analysis categorized any test as screening, which could have inflated our estimates of screening. Our data come from a single health system, which may limit generalizability. However, this system spans 2 states, includes urban and suburban regions, and includes clinics with clinicians who have varying degrees of experience in sexual health care delivery. We had only 2 Title X–funded clinics in our analysis, both of which also provided routine primary care; thus we were unable to assess the effects of stand-alone Title X clinics on receipt of chlamydia screenings, which is an important area for future research given recent federal limitations on Title X funding. The small number of Title X–funded clinics also led to wide CIs in our estimates. Lastly, we were unable to account for chlamydia screening that may have occurred at community-based sites outside the network.

Conclusions

We identified race and ethnicity-based inequities in chlamydia screening for adolescent females across a large primary care network. Future research

TABLE 3— Associations of Patient and Clinic Characteristics and Receipt of Chlamydia Screening Accounting for Race of Patients for Each Clinician, by Well Visits: Pennsylvania and New Jersey, 2015–2019

Characteristics of Well Visits	AOR (95% CI)
Patient characteristics	
Race/ethnicity	
Black race[a]	1.88 (1.65, 2.15)
Other race	1.26 (1.08, 1.46)
Latinx ethnicity	1.18 (0.97, 1.42)
Age, y	1.36 (1.31, 1.41)
Insurance	
Public (Ref)	1
Private	0.79 (0.72, 0.87)
Previous chlamydia screening	8.17 (7.29, 9.16)
Previous chlamydia infection	6.48 (4.46, 9.40)
Clinician characteristics	
Proportion of Black patients per clinician[a]	11.95 (6.85, 20.87)
Clinician type	
General pediatrics attending physician (Ref)	1
Nurse practitioner	1.48 (1.33, 1.65)
Adolescent medicine specialist (attending physician/fellow)	1.93 (1.61, 2.31)
Clinician's years in practice	
≥ 15 y (Ref)	1
< 3 y	1.49 (1.29, 1.71)
3–14 y	1.39 (0.26, 1.53)
Clinic characteristics	
Clinic size	
< 10 clinicians (Ref)	1
10–20 clinicians	1.58 (0.53, 4.69)
≥ 20 clinicians	10.72 (0.53, 216.99)
Clinic type and geography	
Suburban (Ref)	1
Urban Title X	0.88 (0.03, 28.78)
Urban non-Title X	2.96 (0.59, 14.80)

Note. AOR = adjusted odds ratio; CI = confidence interval. The sample size was n = 63 221 individuals.

[a] The difference between individual patients' race (race: 0 = non-Black vs 1 = Black) and the composition of Black vs non-Black patients in encounter-level data (*mblack*) represented the estimated effect of the clinician's implicit bias on the odds that the clinician ordered chlamydia screening (Black = race-*mblack*).

should focus on the combined impact of quality improvement initiatives focusing on standardization of care as well as clinician training to eliminate implicit racial bias. AJPH

ABOUT THE AUTHORS

Sarah Wood and Danielle Petsis are with the PolicyLab and Center for Pediatric Clinical Effectiveness, Children's Hospital of Philadelphia, Philadelphia, PA. Jungwon Min and Vicky Tam are with the Department of Biostatistics and Health Informatics, Children's Hospital of Philadelphia. Julia Pickel is with the Wake Forest School of Medicine, Winston-Salem, NC. Kenisha Campbell is with the Craig-Dalsimer Division of Adolescent Medicine, Children's Hospital of Philadelphia.

CORRESPONDENCE

Correspondence should be sent to: Sarah Wood, MD, MSHP, Children's Hospital of Philadelphia, Roberts Center for Pediatric Research, Suite 11212, Philadelphia, PA 19146 (e-mail: woodsa@chop.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONFLICTS OF INTEREST

No authors have conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

This research was reviewed and deemed exempt by the institutional review boards of the Children's Hospital of Philadelphia and Access Matters, as all activities were secondary analyses of data routinely required for health care purposes and did not require informed consent.

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Neighborhood Racial and Economic Segregation and Disparities in Violence During the COVID-19 Pandemic

Julia P. Schleimer, MPH, Shani A. Buggs, PhD, MPH, Christopher D. McCort, MS, Veronica A. Pear, PhD, MPH, Alaina De Biasi, PhD, Elizabeth Tomsich, PhD, Aaron B. Shev, PhD, Hannah S. Laqueur, PhD, MA, MPA, and Garen J. Wintemute, MD, MPH

Objectives. To describe associations between neighborhood racial and economic segregation and violence during the COVID-19 pandemic.

Methods. For 13 US cities, we obtained zip code–level data on 5 violence outcomes from March through July 2018 through 2020. Using negative binomial regressions and marginal contrasts, we estimated differences between quintiles of racial, economic, and racialized economic segregation using the Index of Concentration at the Extremes as a measure of neighborhood privilege (1) in 2020 and (2) relative to 2018 through 2019 (difference-in-differences).

Results. In 2020, violence was higher in less-privileged neighborhoods than in the most privileged. For example, if all zip codes were in the least privileged versus most privileged quintile of racialized economic segregation, we estimated 146.2 additional aggravated assaults (95% confidence interval = 112.4, 205.8) per zip code on average across cities. Differences over time in less-privileged zip codes were greater than differences over time in the most privileged for firearm violence, aggravated assault, and homicide.

Conclusions. Marginalized communities endure endemically high levels of violence. The events of 2020 exacerbated disparities in several forms of violence.

Public Health Implications. To reduce violence and related disparities, immediate and long-term investments in low-income neighborhoods of color are warranted. (*Am J Public Health*. 2022;112(1): 144–153. https://doi.org/10.2105/AJPH.2021.306540)

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In many places in the United States, interpersonal violence increased during the COVID-19 pandemic to levels not seen in recent history.[1] News reports suggest that this increase was unequally distributed across racial/ethnic groups,[2] where disparities are already stark.[3]

The pandemic has exacerbated social and structural conditions that contribute to violence and associated racial/ethnic inequities, including economic and housing instability,[4,5] lack of access to resources and support services,[6,7] and neighborhood social disorganization.[8,9] Simultaneously, political violence by White supremacists and violence against Black people at the hands of the state have spurred national outrage, despair, and trauma.[10]

Although research has demonstrated increases in violence in US cities during the COVID-19 pandemic,[1,11] no studies have, to our knowledge, documented among whom or where—in cities—the burden of violence was highest. Existing aggregate estimates likely mask substantial variation by sociodemographics and place. We are not aware of comprehensive recent data on the characteristics of individuals injured by violence, but, because of pervasive racial and socioeconomic residential segregation,[12] detailed geographic estimates of health outcomes can provide information on who is affected and social and environmental conditions that might contribute to risk.

We drew on place-based social measures to document disparities in violence during the first months of the pandemic. We constructed measures of racial, economic, and racialized economic segregation (using the Index of Concentration at the Extremes [ICE]), comparing rates of firearm violence and other violent crime (homicide, aggravated assault, robbery, and rape) in zip codes in 13 major US cities. We had 2 aims. First, we examined cross-sectional differences between zip codes in 2020 to determine where the burden of violence was highest during the first months of the pandemic. Second, we examined zip code differences in 2020 relative to such differences in previous years (i.e., difference-in-differences) to identify differential change over time between less versus more privileged zip codes, isolating the unique contribution of the pandemic context.

METHODS

We selected 13 major US cities that represent a geographic and sociopolitical range and made data on crime during our study period publicly available through open data portals: Baltimore, Maryland; Boston, Massachusetts; Chicago, Illinois; Cincinnati, Ohio; Dallas, Texas; Denver, Colorado; Detroit, Michigan; Los Angeles, California; Milwaukee, Wisconsin; Philadelphia, Pennsylvania; Phoenix, Arizona; San Francisco, California; and Seattle, Washington. The study period was March through July in 2018, 2019, and 2020.

Data

Outcomes. We examined 5 outcomes: intentional, interpersonal firearm violence (hereafter "firearm violence") and the Federal Bureau of Investigation's Uniform Crime Reporting Part I violent crime offenses: criminal homicide, rape, robbery, and aggravated assault.

We downloaded data on police-reported crime incidents (except for firearm violence) from open data portals (Table A, available as a supplement to the online version of this article at http://www.ajph.org for data sources). We coded crimes to maximize comparability across cities, although classifications varied somewhat (e.g., some cities reported more detailed categories, and some made exclusions; Table A). We accounted for between-city differences with city fixed effects ("Analysis" section). Zip codes were the smallest geographic unit provided in the data. We report counts of incidents rather than victims (although multiple victims may be involved in a single incident) because data were consistently reported only at the incident level.

Firearm violence data came from the Gun Violence Archive, a real-time repository for firearm violence incidents compiled from approximately 7500 news outlets and other public sources;[13] most cities' data portals did not include information on firearm-involved crime. Each incident record in the Gun Violence Archive includes basic descriptive information, the location, and the number of people injured or killed. We geocoded incidents to obtain latitude and longitude. We included all incidents of intentional, interpersonal firearm violence in which at least 1 person was injured or killed.

We assigned incidents of firearm violence and police-reported crimes to zip codes and summed counts from March through July in each year (2018, 2019, 2020). We excluded incidents that did not correspond to Zip Code Tabulation Areas (ZCTA; see "Exposures" section) in our cities, did not contain valid geographic information, or were in ZCTAs with no population. We excluded cities from analyses that were missing crime data or had fewer than 5 incidents annually for that outcome citywide: San Francisco and Seattle for homicide; Boston, Dallas, Denver, Detroit, Milwaukee, and Seattle for rape.

Exposures. We used the ICE to measure racial and economic spatial segregation. The ICE quantifies the extent to which individuals in a neighborhood (here, zip code) are concentrated in the extremes of the distribution of socioeconomic characteristics (here, race and income). Unlike other commonly used measures, the ICE is meaningful at the neighborhood level and provides information on the direction, not just magnitude, of spatial concentration.[14] For example, the Dissimilarity Index compares a larger geographic unit (e.g., city) to smaller geographic units (e.g., zip codes), returning a single metric of segregation for the larger unit as a whole.

We used the formula $ICE_i = (A_i - P_i)/T_i$, where A_i, P_i, and T_i reflect the number of people in neighborhood i belonging to the most privileged group, the least privileged group, and the total population, respectively. The ICE thus ranges from −1 (all residents belong to the least privileged group) to +1 (all residents belong to the most privileged group). The ICE has been previously used in research on zip code–level health disparities.[15]

Similar to previous work,[14] we computed 3 versions of the ICE: (1) income, comparing households with incomes of $100 000 or greater (most privileged) to households with incomes of $24 999 or less (least privileged); (2) race, comparing White people of all ethnicities (most privileged) to Black people of all ethnicities (least privileged), with race reflecting socially constructed hierarchies and risk for exposure to racism;[16] and (3) race–income, comparing White households with incomes of $100 000 or greater (most privileged) to Black households with incomes of $24 999 or less (least privileged). The race–income measure avoids collinearity problems that arise from including separate measures for each in 1 model.[14] We adapted code from the Public Health Disparities Geocoding Project[17] to obtain these data and population data from the American Community Survey (2015–2019 estimates) for ZCTAs, which are stable geographic units defined by the US Census Bureau designed to reflect US Postal Service zip code boundaries.

ZCTAs (and zip codes) do not nest neatly in cities; based on visual inspection of the geographic overlap, we excluded a ZCTA if more than 75% of its land area was outside the city. Although our outcome data sources included incidents that occurred slightly outside the city bounds, we made this restriction to minimize potential bias from unobserved missing data (i.e., inconsistent measurement of crimes outside the city, which may be correlated with neighborhood characteristics).

We binned ICE estimates into quintiles, as done previously,[14,15] for each city separately to avoid extrapolating beyond the data (i.e., ensuring all cities included zip codes in all quintiles) and because our interest is within-city variation. City-specific cutoffs are shown in Tables B through D (available as a supplement to the online version of this article at http://www.ajph.org).

Analysis

First, we described the total number of incidents per outcome (i.e., homicide, rape, robbery, aggravated assault, and firearm violence) from March through July in each year, along with the rate per population.

Second, we quantified cross-sectional differences in outcomes between ICE quintiles in 2020, with the most privileged quintile (Q5) as the referent. These estimates describe whether violence during the pandemic was disproportionately concentrated in less-privileged zip codes in a city compared with the most privileged zip codes. We used negative binomial regression models (which provided better fit than Poisson), including the log of the zip code population as an offset to adjust for population size. Models included city fixed effects, so we made all comparisons in, rather than between, cities. The exposure was a categorical variable for ICE quintiles (with separate models for each ICE measure: race, income, and race–income), and the outcome was counts of incidents from March through July in 2020 (with separate models for each outcome). We included zip code median age and percentage male as covariates.

Using the fitted models, we then estimated the marginal difference in the number of incidents associated with ICE quintiles by predicting counts under each level of the exposure, holding other variables (including population size) at their observed levels and taking the average difference.[18] Sometimes called "standardization" or "g-computation," this approach involves estimating conditional associations (adjusted for covariates), which are then used to generate marginal estimates of the expected outcome, standardized to the population's covariate distribution.[19] This allows us to estimate associations on the additive scale, which is most relevant for understanding public health impacts.[20]

Third, we estimated change in violence over time (2020 vs 2018–2019) between quintiles of ICE measures. These difference-in-differences estimates describe whether violence increased (or decreased) disproportionately during the pandemic versus before the pandemic in less-privileged zip codes compared with the most privileged zip codes. We used negative binomial regression models and the marginal estimation approach we have described, but we included an interaction between time (an indicator equal to 1 if the year was 2020 and 0 if 2018 or 2019) and the categorical ICE measure wherein the interaction terms and associated marginal contrasts correspond to difference-in-differences estimates. That is, the interaction reflects the difference over time in the least privileged zip codes minus the difference over time in the most privileged. Because this approach differences out stable characteristics of place, we did not include median age or percentage male.

The use of marginal contrasts to estimate differences is advantageous because relative measures (e.g., ratios) do not account for baseline rates, whereas absolute measures do. For example, the public health implications of doubling a rate per 100 000 from 5 to 10 over time are different from doubling a rate from 1 to 2, yet the rate ratio for both is 2. Relative measures of association can therefore obscure potentially important public health effects of the exposure for communities in which the outcome is more common.

We calculated confidence intervals (CIs) for all estimates with bias-corrected clustered bootstraps with 500 iterations. We performed analyses in R version 4.0.0 (R Foundation for Statistical Computing, Vienna, Austria) and Stata version 15.1 (StataCorp, College Station, TX).

Additional Analyses

We conducted 3 additional analyses. First, we computed ICE race/ethnicity measures comparing non-Latinx White people to all people of color because our main analysis, which included Latinx White individuals and non-Latinx White individuals together in the most privileged group, may be attenuated toward the null, given disparities in violence and associated risk factors between these groups. These measures compared non-Latinx White people (most privileged) to people of color (least privileged), and non-Latinx White households with incomes of $100 000 or more (most privileged) to households of people of color with incomes of $24 999 or less (least privileged). Second, we estimated associations for firearm violence injuries (nonfatal and fatal), as opposed to incidents. (We had consistent data on numbers of victims for this outcome only.) Third, we excluded cities with fewer than 20 events annually for an outcome citywide; this resulted in the additional exclusion of San Francisco for rape.

RESULTS

We excluded 3178 incidents. Exclusions ranged from 0% for many outcomes to 10% for firearm violence in Denver and averaged 2.7% of incidents (interquartile range = 1.0%–3.7%). Of excluded incidents, 34.5% did not contain valid geographic information, 0.7% did not correspond to a ZCTA, 0.9% were in ZCTAs with no population, and 63.9% were in ZCTAs that fell outside city boundaries.

Descriptive

The correlation between ICE measures was strong: 0.7 for ICE race and ICE income and 0.9 for ICE income and ICE race–income.

Aggravated assault was the most common and homicide the least common crime (Table 1). Overall during the pandemic, firearm violence increased 29.3% (from 15.0 per 100 000 population in 2018–2019 to 19.4 per 100 000 in 2020); assault increased 4.0% (from 198.7 to 206.6 per 100 000); homicide increased 27.7% (from 6.0 to 7.6 per 100 000); robbery decreased 23.3% (from 112.15 to 86.0 per 100 000); and rape decreased 31.4% (from 19.4 to 13.3 per 100 000).

On average, zip code median age was 35.6 years (SD = 5.5) and 50% of zip code populations were male (SD = 5%).

Difference Across Quintiles in 2020

For every outcome, in multivariable regression models controlling for median age and percentage male, less-privileged neighborhoods experienced a higher burden of violence in 2020 than the most privileged neighborhoods (findings were essentially unchanged in unadjusted models).

TABLE 1— Description of Violence Outcomes in 13 US Cities: March–July 2018, 2019, and 2020

Outcome and Year	Total No. Incidents	Total No. Incidents per 100 000 Population	Total No. Zip Codes
Firearm violence			
2018	2526	14.6	520
2019	2667	15.4	520
2020	3356	19.4	520
Aggravated assault			
2018	34 229	197.7	520
2019	34 567	199.7	520
2020	35 763	206.6	520
Homicide[a]			
2018	909	5.8	465
2019	957	6.1	465
2020	1195	7.6	465
Robbery			
2018	20 004	115.5	520
2019	18 829	108.8	520
2020	14 894	86.0	520
Rape[b]			
2018	2397	19.6	335
2019	2346	19.2	335
2020	1631	13.3	335

Note. The 13 US cities were Baltimore, MD; Boston, MA; Chicago, IL; Cincinnati, OH; Dallas, TX; Denver, CO; Detroit, MI; Los Angeles, CA; Milwaukee, WI; Philadelphia, PA; Phoenix, AZ; San Francisco, CA; and Seattle, WA.

[a] Seattle and San Francisco were excluded because of missing outcome data or low counts (< 5 citywide).
[b] Boston, Dallas, Denver, Detroit, Milwaukee, and Seattle were excluded because of missing outcome data or low counts (< 5 citywide).

Results were consistent across all ICE measures (race, income, and race–income). For example, we estimated that, on average across cities, if all zip codes were in the least privileged quintile (Q1) of ICE race–income, there would be approximately 14.1 more firearm violence incidents (95% CI = 5.9, 31.8; Figure 1a), 146.2 more aggravated assaults (95% CI = 112.4, 205.8; Figure 2a), and 4.9 more homicides (95% CI = 2.7, 9.0; Figure 3a) per zip code, than if all zip codes were in the most privileged quintile (Q5). These averages represent a range because cities vary in their baseline rates, and they should be interpreted in context. For example, the total number of aggravated assaults in March through July 2020 per 100 000 population ranged from 93.8 in Dallas (1416 assaults) to 822.6 in Milwaukee (5721 assaults). Results for robbery and rape show the same pattern (Figures A and B, panel A, available as a supplement to the online version of this article at http://www.ajph.org).

Relative Differences Over Time

Disparities in change over time between quintiles were not consistent across outcomes. We found larger increases from 2018 through 2019 to 2020 in less-privileged quintiles than in the most privileged quintile for 3 outcomes: firearm violence, homicide, and aggravated assault (difference-in-differences estimates shown in Figures 1–3, part b). Relative to 2018 through 2019, we estimated an increase of 2.3 firearm violence incidents (95% CI = 0.5, 6.7; Figure 1b), 22.5 aggravated assaults (95% CI = 5.0, 44.7; Figure 2b), and 0.9 homicides (95% CI = 0.1, 2.2; Figure 3b) per zip code on average across cities associated with the least privileged versus the most privileged quintile of ICE

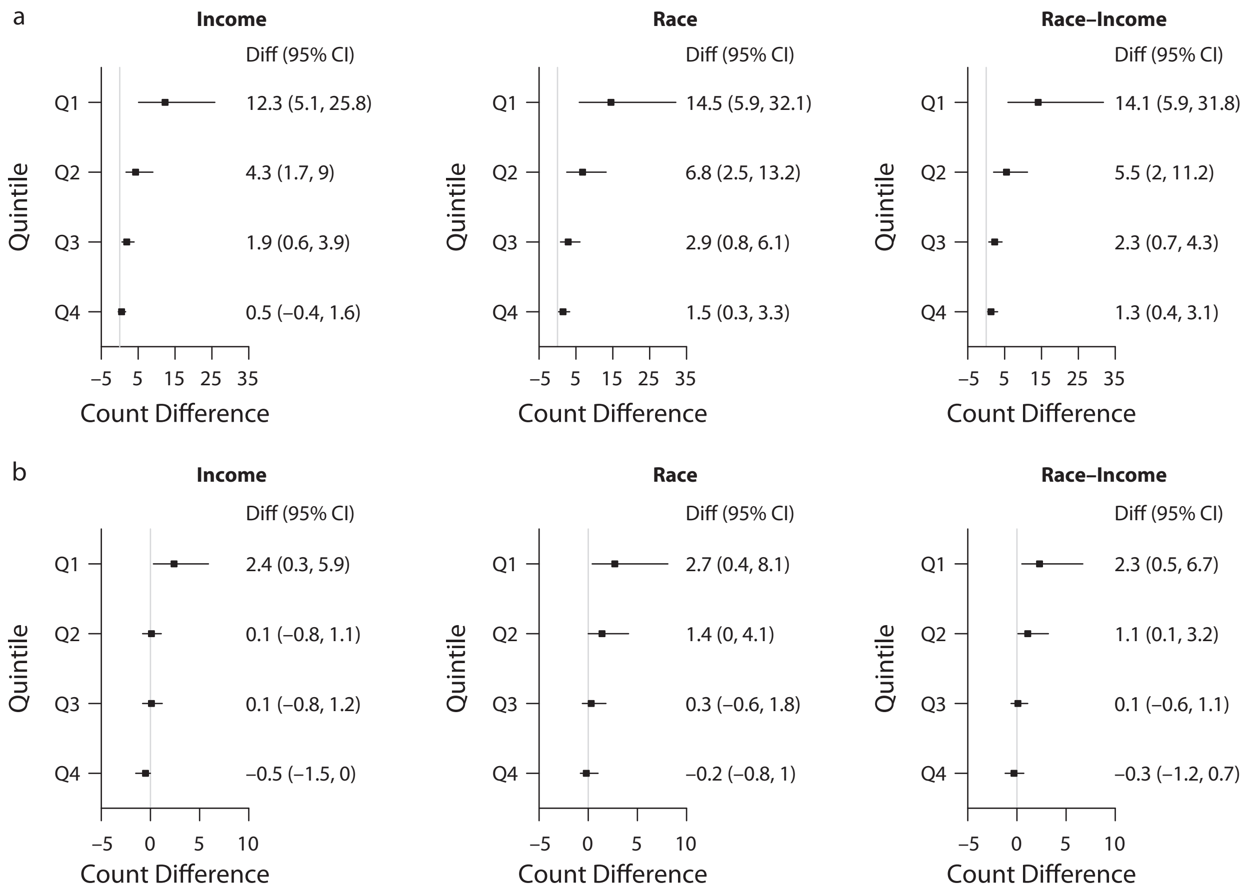

FIGURE 1— **Association Between Zip Code Index of Concentration at the Extremes (ICE) Income, Race, and Race–Income Measures and Firearm Violence in 13 US Cities, March–July by (a) Difference Across ICE Quintiles in 2020, and (b) Difference in 2020 Relative to 2018–2019 Across ICE Quintiles**

Note. CI = confidence interval; Diff = difference in count of incidents. The most privileged quintile (Q5) is the referent. Results in part a reflect cross-sectional differences between quintiles in 2020. Results in part b reflect difference-in-differences estimates of change over time (2020 vs 2018–2019) between quintiles.

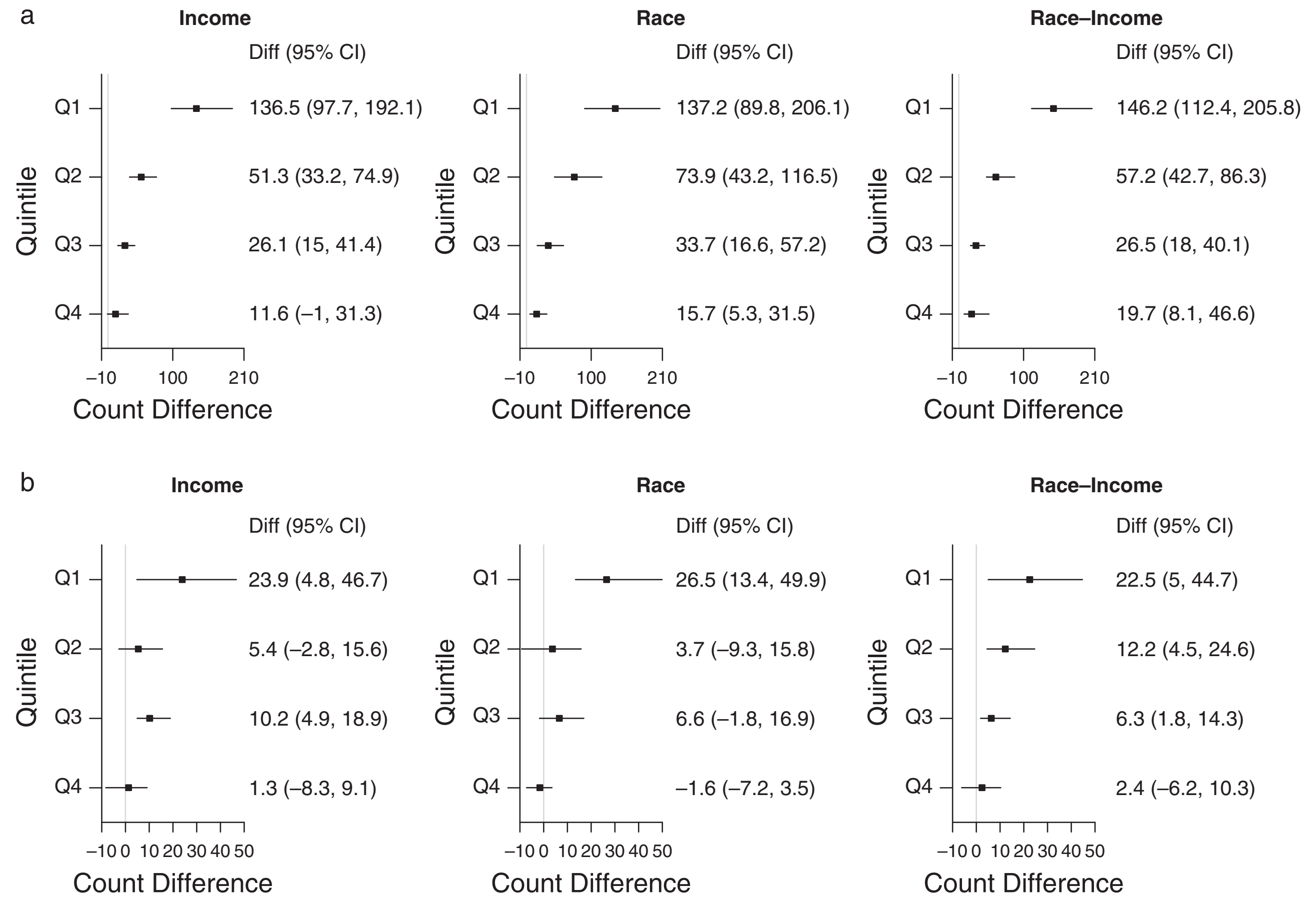

FIGURE 2— **Association Between Zip Code Index of Concentration at the Extremes (ICE) Income, Race, and Race–Income Measures and Aggravated Assault in 13 US Cities, March–July by (a) Difference Across ICE Quintiles in 2020, and (b) Difference in 2020 Relative to 2018–2019 Across ICE Quintiles**

Note. CI = confidence interval; Diff = difference in count of incidents. The most privileged quintile (Q5) is the referent. Results in part a reflect cross-sectional differences between quintiles in 2020. Results in part b reflect difference-in-differences estimates of change over time (2020 vs 2018–2019) between quintiles.

race–income in 2020. These results were similar across race, income, and race–income ICE measures. Robbery and rape exhibited relative decreases in less-privileged zip codes for some or all ICE measures (Figures A and B, panel b).

Additional Analyses

Results for ICE race/ethnicity and race/ethnicity–income measures that compared non-Latinx White people to all persons of color were similar to those from the main analyses (Figures C–G, available as a supplement to the online version of this article at http://www.ajph.org).

Results for firearm violence injuries (Figure H, available as a supplement to the online version of this article at http://www.ajph.org) were consistent with results for firearm violence incidents.

Excluding cities with fewer than 20 events annually citywide did not change the results (not shown).

DISCUSSION

In this study of 13 large US cities, we quantified place-based social disparities in violence (1) cross-sectionally during the first months of the COVID-19 pandemic, and (2) over time relative to years past. Zip codes with higher concentrations of low-income households and higher concentrations of either Black people or all people of color experienced substantially higher rates of violence from March through July 2020 than did zip codes with higher concentrations of high-income households and White people. For firearm violence, aggravated assault, and homicide, inequities increased during the pandemic. Our findings are consistent with previous studies documenting stark racial and socioeconomic differences in violence[21] and with news

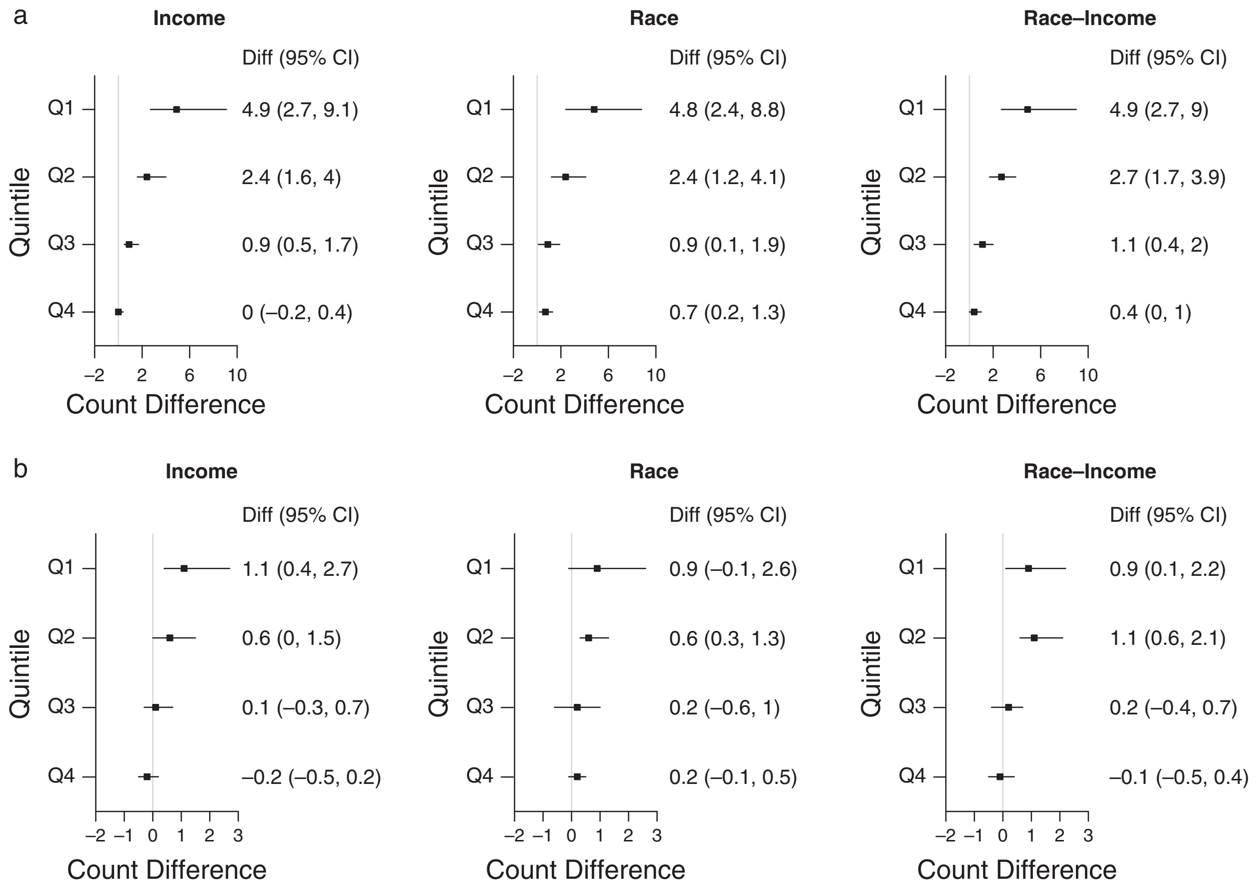

FIGURE 3— Association Between Zip Code Index of Concentration at the Extremes (ICE) Income, Race, and Race–Income Measures and Homicide in 11 US Cities, March–July by (a) Difference Across ICE Quintiles in 2020, and (b) Difference in 2020 Relative to 2018–2019 Across ICE Quintiles

Note. CI = confidence interval; Diff = difference in count of incidents. The most privileged quintile (Q5) is the referent. Results in part a reflect cross-sectional differences between quintiles in 2020. Results in part b reflect difference-in-differences estimates of change over time (2020 vs 2018–2019) between quintiles. San Francisco and Seattle were excluded because of missing outcome data or low counts (< 5 citywide).

media reports showing a disproportionate rise in violence in marginalized communities during the pandemic.[2]

Future research should examine the factors driving this disproportionate increase. For example, what impact has the closure of schools and community organizations had on violence in segregated and disinvested communities? The fact that homicide and assault, but not robbery and rape, rose disproportionately in disadvantaged neighborhoods suggests that these communities experienced disparate exposure to conditions during the pandemic that uniquely affected risk for these types of violence.

Robbery and rape decreased disproportionately in less-privileged zip codes (where they were already higher) compared with the most privileged zip codes. These were the only 2 outcomes that declined overall in 2020, so results may reflect the fact that relative declines of the same magnitude correspond to greater absolute declines in areas with higher baseline rates (exploratory analyses of rate ratios showed no significant disproportionate changes over time). The overall decline in robbery and rape may be real or an artifact of changes in reporting. For example, shelter-in-place orders may have reduced stranger rape or limited victims' ability or willingness to report intimate partner rape. Again, research is needed to understand the drivers of these trends.

Our results have 2 main implications. First, given the substantial and growing burden of violence in low-income neighborhoods of color, there is a need for focused violence prevention strategies that address the unique challenges of the pandemic. Recent federal commitments to invest in community violence prevention are encouraging,[22] and existing empirical evidence supports a number of actionable steps.[23] For example, reducing economic and housing instability (e.g., through temporary financial assistance and eviction bans during the pandemic) and improving the physical environment and outdoor green spaces (which can promote collective efficacy while minimizing risks of coronavirus transmission) may curb or reduce violence.[23]

A growing body of literature also documents the success of focused interventions that engage individuals most affected by violence, such as Advance Peace and Cure Violence.[24] Chronic underfunding and the pandemic have brought challenges to implementation, including physical-distancing requirements, disruptions in client engagement, interruptions in service and resource provisions, and additional demands on outreach workers,[25] but preliminary evidence suggests that such programs have adapted.[25] This resilience, combined with appropriate investment and resources (including funding staff, designating them essential workers, and providing personal protective equipment during the pandemic), indicates that these interventions may be especially critical for reducing violence in the current context. Similarly, comprehensive, trauma-informed care for those injured by violence, including hospital-based violence intervention programs, may help interrupt the cycle of violence,[26] although these programs too have been hampered by the pandemic.[27] Support for those indirectly exposed to violence is also warranted.

Second, our results affirm well-documented associations between the spatial concentration of violence and low-income and marginalized racial/ethnic groups[28] and challenge policymakers and those interested in improving public health to examine the historical and contemporary processes that contribute to these enduring inequities. For example, neighborhoods “redlined” by the Homeowner’s Loan Corporation in the 1930s (i.e., neighborhoods with large Black and immigrant populations) experience higher rates of firearm violence today than do neighborhoods deemed most desirable.[29] This past de jure segregation[30] may be related to present-day violence via impacts on education, transportation, jobs, income and wealth, and the built environment.[31]

Mass incarceration of Black men, another example of structural racism in the United States,[32] and its direct and indirect consequences (e.g., on educational and employment opportunities) have contributed to family disruption and, in turn, potentially elevated the risk of violence, particularly among youths.[33] The socioecological factors underlying these disparities are not unique to violence, and there is growing consensus that racism is a public health crisis[34] with pervasive impacts. Additional research on the embodiment of structural racism may contribute to our conceptualization of health disparities and the advancement of policies that promote equity and justice. Continued surveillance of health disparities will be critical in these efforts.

Limitations

Exposures and outcomes may be measured with error. For example, crime data rely on police reports, which do not capture all incidents; changes in incident reporting over time could bias results but likely toward the null, given strains between police and low-income communities of color during the pandemic. Coding systems varied slightly across cities (e.g., Dallas excluded incidents if the victim or suspect was younger than 17 years), but these differences are unlikely to influence results because we focused on within-city comparisons. Gun Violence Archive data are based, in part, on news reports and other public sources and may, therefore, fail to capture all instances of firearm violence or accurately record their circumstances. However, the Gun Violence Archive is the most comprehensive, real-time source of data on firearm violence to our knowledge, and it has been shown to correlate well with official firearm homicide data from the Centers for Disease Control and Prevention[35] (no such data on nonfatal firearm injury exist).

Place-based social measures are from 2015 to 2019 (the most recent estimates available), whereas outcomes were measured in 2018 through 2020. There is also likely to be some degree of mismatch between ZCTAs and zip codes. This is reflected, in part, by missing data (2.7% of incidents were missing, on average). Zip codes are relatively small geographic areas, and some of our estimates are accompanied by wide CIs. We based our selection of 13 large US cities on convenience in accessing data; the selection is not nationally representative and may not generalize to other cities. Lastly, our data only go through July 2020, but the pandemic continues. Future research should examine whether continued consequences of the pandemic lead to even wider variation across categories of advantage.

Public Health Implications

Evidence on the social distribution of violence is critical to guide equitable prevention and response measures.

We show that the least privileged communities endure endemically high levels of violence and that the COVID-19 pandemic and the events of 2020 had inequitable impacts, exacerbating disparities in some of the most severe forms of violence. Immediate mitigation strategies that address the unique challenges of the pandemic and long-term investments in antiracist programs and policies that address economic inequality are warranted. AJPH

ABOUT THE AUTHORS

All authors are with the Violence Prevention Research Program, Department of Emergency Medicine, University of California, Davis, and the California Firearm Violence Research Center.

CORRESPONDENCE

Correspondence should be sent to Julia P. Schleimer, 2315 Stockton Blvd, Sacramento, CA 95817 (e-mail: jpschleimer@ucdavis.edu). Reprints can be ordered at http://www.ajph.org by clicking the “Reprints” link.

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CONTRIBUTORS

J. P. Schleimer developed the research question and study design, conducted the analyses, and drafted the article. S. A. Buggs contributed to the conceptualization of the research and study design. C. D. McCort and V. A. Pear assisted with data acquisition and management. C. D. McCort, V. A. Pear, A. B. Shev, and H. S. Laqueur advised on the statistical analyses. All authors contributed to study design, interpretation of results, and critical revision of the article and gave approval of the final version to be published.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

HUMAN PARTICIPANT PROTECTION

This study was approved by the University of California, Davis institutional review board.

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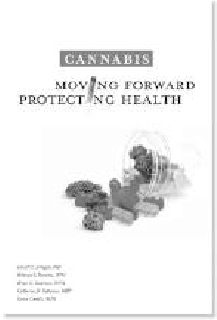

Racial/Ethnic and Age Differences in the Direct and Indirect Effects of the COVID-19 Pandemic on US Mortality

Lauren C. Zalla, MS, Grace E. Mulholland, MSPH, Lindsey M. Filiatreau, PhD, and Jessie K. Edwards, PhD

Objectives. To estimate the direct and indirect effects of the COVID-19 pandemic on overall, race/ethnicity–specific, and age-specific mortality in 2020 in the United States.

Methods. Using surveillance data, we modeled expected mortality, compared it to observed mortality, and estimated the share of "excess" mortality that was indirectly attributable to the pandemic versus directly attributed to COVID-19. We present absolute risks and proportions of total pandemic-related mortality, stratified by race/ethnicity and age.

Results. We observed 16.6 excess deaths per 10 000 US population in 2020; 84% were directly attributed to COVID-19. The indirect effects of the pandemic accounted for 16% of excess mortality, with proportions as low as 0% among adults aged 85 years and older and more than 60% among those aged 15 to 44 years. Indirect causes accounted for a higher proportion of excess mortality among racially minoritized groups (e.g., 32% among Black Americans and 23% among Native Americans) compared with White Americans (11%).

Conclusions. The effects of the COVID-19 pandemic on mortality and health disparities are underestimated when only deaths directly attributed to COVID-19 are considered. An equitable public health response to the pandemic should also consider its indirect effects on mortality. (*Am J Public Health*. 2022;112(1):154–164. https://doi.org/10.2105/AJPH.2021.306541)

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Most reports of US mortality associated with the COVID-19 pandemic have focused on deaths caused by infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Such reports overlook the many indirect pathways through which the pandemic has affected mortality, despite evidence that deaths attributed to COVID-19 accounted for only 66% to 72% of all pandemic-related mortality in 2020.[1,2] Estimates of total pandemic-related mortality typically evaluate "excess deaths" (i.e., the difference between the total number of deaths that occurred during the pandemic and the number expected for that same period in absence of the pandemic, given historical trends in all-cause mortality). As of May 20, 2021, the Centers for Disease Control and Prevention (CDC) estimated that between 431 924 and 503 372 excess deaths occurred in the United States in 2020,[3] whereas COVID-19 was documented as a primary or underlying cause of 384 098 deaths in 2020,[4] implying that between 11% and 24% of pandemic-related deaths in 2020 were not captured in official surveillance data on deaths from COVID-19.

National figures, however, do not reveal how the pandemic has affected different population groups. We know that the risk of dying from COVID-19 varies by age, gender, race, ethnicity, and other sociodemographic characteristics because of differences in exposure probability (e.g., Black, Latinx, and Indigenous people are more likely, as a result of structural racism, to live and work in places that are conducive to the spread of SARS-CoV-2[5,6]) and susceptibility (e.g., older adults are more likely to develop severe COVID-19[7]). The risk of dying from an indirect consequence of the pandemic, such as social isolation, economic insecurity, or disrupted medical care, is also likely to vary across population groups.[8] Quantifying group differences in the risks of dying from direct versus indirect effects of the pandemic can lay the groundwork for a more tailored and equitable public health response to the pandemic.

In this analysis, we used surveillance data from 2015 to 2020 to model expected mortality in 2020 and compared it to observed mortality in 2020. Using death certificate data, we estimated the risk of death and proportion of total pandemic-related mortality directly attributed to COVID-19. Under the assumption that the remaining excess deaths represent the social and economic effects of the pandemic on mortality, we present estimates of the risk of death and proportion of total pandemic-related mortality indirectly attributable to the pandemic. We examine group differences in the magnitude and composition of pandemic-related mortality by presenting age- and race/ethnicity–specific estimates in addition to national estimates.

METHODS

The National Center for Health Statistics (NCHS), a division of the CDC, began releasing provisional counts of deaths from all causes and deaths attributed to COVID-19, grouped by CDC *Morbidity and Mortality Weekly Report (MMWR)* week, in April 2020.[1,9] Deaths attributed to COVID-19 are defined as deaths with COVID-19 listed as an immediate or underlying cause of death on the death certificate, including deaths among people with suspected, but not laboratory-confirmed, COVID-19. Provisional counts of deaths were upweighted to account for incomplete reporting in more recent weeks, with weights estimated based on the completeness of provisional data in the reporting jurisdiction in 2018 to 2019. For this analysis, we used counts of deaths that occurred between January 3, 2015, and December 31, 2020, and were reported to the NCHS by August 1, 2021. Death counts were classified by race/ethnicity as recorded on the death certificate (Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, non-Hispanic American Indian/Alaska Native, non-Hispanic Native Hawaiian/Pacific Islander, and other or unknown) and by age group (0–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, and ≥ 85 years). Age group was missing for 796 decedents (< 0.01%); race/ethnicity was reported as other or unknown for 101 664 (0.74%). We excluded deaths with missing sociodemographic information only from the relevant group-specific estimates. We obtained monthly population estimates for 2015 to 2020 from the US Census Bureau.[10]

Estimation of Expected Deaths

We used data on deaths that occurred between January 3, 2015, and February 29, 2020, to estimate expected counts of deaths during the pandemic period (i.e., the number of deaths we expect to have observed in the absence of the pandemic). We assumed that the pandemic period began on March 1, 2020. We modeled deaths in the prepandemic period using quasi-Poisson regression to account for overdispersion of death counts, following the approach used by the CDC.[1] We used separate models to predict expected death counts at the national level, overall and for each age group, each racial/ethnic group, and each combination of age group and racial/ethnic group. Each model accounted for secular trends by using a linear term for epidemiological year, and for seasonal trends by using restricted quadratic spline terms for *MMWR* week, with knots placed at the weeks representing percentiles of the observed distribution of deaths (10th, 25th, 50th, 75th, and 90th). We used the estimated model coefficients to predict death counts for each *MMWR* week between March 1 and December 31, 2020. Details about the specification and fit of the models are provided in Appendix A (available as a supplement to the online version of this article at http://www.ajph.org), and plots of observed and predicted death counts are provided in Appendix D. While models were fit by epidemiological year (July to June) to more smoothly model the rise and fall in deaths that occurs each winter and spring, the plots show observed and predicted death counts by calendar year (January to December).

Estimation of Risks of Death

Using observed and predicted counts of deaths, we estimated observed and expected risks of death in 2020. We intentionally report risks because of their advantages over more commonly reported mortality rates. Whereas rates are averaged over time, and contrasts of rates (e.g., rate differences and ratios) are noncollapsible, risks are explicitly a function of time, and their contrasts are collapsible, making risks easier to compare across studies and across time periods.[11] Moreover, risks of death have a convenient interpretation as the "average" probability of death among individuals alive at the beginning of the risk period (i.e., the probability that a person randomly selected from the population on January 1, 2020, would survive to a particular week of 2020), whereas rates do not apply to individual population members.

To estimate risks, we first accounted for the impacts of aging on age-group membership over the course of the year by adjusting observed and predicted death counts to reflect the age groups of decedents as of January 1, 2020. Details are provided in Appendix B (available as a supplement to the online version of this article at http://www.ajph.org). We then merged the observed and predicted death counts for 2020 with population denominators to estimate the observed risk of death from all causes, the expected risk of death from all causes, and the observed risk of death from COVID-19 for each *MMWR* week of 2020. The observed risk of death from all causes was estimated as $F(t)_{obs} = \frac{O_t}{N}$, where O_t indicates the cumulative count of observed deaths through *MMWR* week t, and N indicates the size of the population on January 1, 2020, as estimated by the US Census Bureau.[10] The expected risk of death from all causes was estimated as $F(t)_{exp} = \frac{E_t}{N}$, where E_t indicates the cumulative count of predicted deaths through *MMWR* week t. We estimated the excess risk of death from all causes as the difference between the observed and expected risks of death from all causes (i.e., $F(t)_{obs} – F(t)_{exp}$). Finally, we estimated the share of the excess risk of death in 2020 that was indirectly attributable to the pandemic as the difference between the excess risk of death from all causes and the observed risk of death from COVID-19. To estimate the uncertainty around our estimates, we constructed 95% confidence intervals (CIs) based on the empirical distribution of estimates obtained from 10 000 bootstrap samples of the data (details provided in Appendix C, available as a supplement to the online version of this article at http://www.ajph.org). We conducted all analyses in SAS version 9.4 (SAS Institute, Cary, NC).

To interpret our results, we relied on the following assumptions: (1) our statistical models for expected deaths correctly predict the number of deaths that would have occurred during the pandemic period in the absence of the pandemic; (2) if not for the pandemic, individuals who died in 2020 and whose deaths were directly or indirectly attributable to the pandemic would still have been alive on December 31, 2020; and (3) medical examiners are able to correctly distinguish cause of death such that all deaths caused by COVID-19 are captured using *International Classification of Diseases, Tenth Revision* (https://bit.ly/3xiSWDQ) code U07.1.

RESULTS

We estimated that US mortality was 17% higher than expected in 2020, corresponding to 16.6 excess deaths per 10 000 population (95% CI = 16.4, 16.7; Table 1; Figure 1). Equivalently, 1 in 602 (95% CI = 1 in 610, 1 in 599) US residents who were alive on January 1, 2020, died as a direct or indirect result of COVID-19 by December 31, 2020. Of those deaths, 84% were directly attributed to COVID-19. The remaining 16% represent deaths indirectly attributable to the pandemic: an absolute risk of 2.7 deaths per 10 000 population (95% CI = 2.5, 2.8).

In our analyses of age-specific mortality, we found that the magnitude of excess mortality increased dramatically with age, consistent with prepandemic mortality patterns as well as the age distribution of deaths attributed to COVID-19 (Figure 2). The percentage increase in observed mortality relative to expected mortality, which accounts for age differences in prepandemic mortality, was similar across age groups, with the exception of children aged 0 to 14 years. The risk of death was 3% lower than expected among children aged 0 to 14 years (95% CI = −4.5, −1.3), and higher than expected in all other age groups, ranging from 13% higher among adults aged 85 years and older (95% CI = 12.8, 13.4) to 24% higher among adults aged 40 to 44 years (95% CI = 22.8, 25.6). In contrast, the proportion of excess mortality directly attributed to COVID-19 varied widely by age group, from 9% among decedents aged 15 to 19 years to 100% among decedents aged 85 years and older. In the age group with the largest percentage increase in observed versus expected mortality, adults aged 40 to 44 years, only 40% of excess deaths were directly attributed to COVID-19.

In analyses of race/ethnicity–specific mortality, we found that the magnitude of excess mortality varied widely across groups (Figure 3). The 1-year risk of excess mortality was higher than the national average among decedents identified as American Indian or Alaska Native (25.2 deaths per 10 000) or Black (22.2 deaths per 10 000), and lower than the national average among decedents identified as Hispanic (13.8 deaths per 10 000), White (13.6 deaths per 10 000), Native Hawaiian or Pacific Islander (12.4 deaths per 10 000), or Asian (8.6 deaths per 10 000).

Differences in the magnitude of excess mortality reflect the disproportionate burden of the pandemic on racially minoritized groups as well as prepandemic mortality patterns. These prepandemic mortality patterns are

TABLE 1— One-Year Observed, Expected, and Excess Risks of Death Among US Residents From January 1 to December 31, 2020

	Observed Risk of Death (O), Deaths per 10 000 Population	Expected Risk of Death (E), Deaths per 10 000 Population	Increase in the Risk of Death, (O–E)/E, % (95% CI)	Excess Risk of Death From All Causes, Deaths per 10 000 Population (95% CI)	Excess Risk of Death Directly Attributed to COVID-19		Excess Risk of Death Indirectly Attributable to the Pandemic	
					Deaths per 10 000 Population (95% CI)	% of All Excess Deaths	Deaths per 10 000 Population (95% CI)	% of All Excess Deaths
Overall	115.8	99.2	16.7 (16.5, 16.9)	16.6 (16.4, 16.7)	13.9 (13.9, 14.0)	84.0	2.7 (2.5, 2.8)	16.0
By age group, y								
0–14	4.9	5.1	−2.9 (−4.5, −1.3)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	. . .[a]	0.0 (0.0, 0.0)	. . .[a]
15–19	7.0	5.9	18.7 (16.0, 21.4)	1.1 (1.0, 1.2)	0.1 (0.1, 0.1)	9.2	1.0 (0.8, 1.1)	90.8
20–24	11.6	9.6	20.8 (18.8, 22.8)	2.0 (1.8, 2.2)	0.2 (0.2, 0.3)	12.2	1.7 (1.6, 1.9)	87.8
25–29	14.7	12.6	16.5 (14.9, 18.2)	2.1 (1.9, 2.3)	0.4 (0.4, 0.5)	21.5	1.6 (1.4, 1.8)	78.5
30–34	18.6	15.5	20.0 (18.5, 21.6)	3.1 (2.9, 3.3)	0.8 (0.8, 0.8)	26.0	2.3 (2.1, 2.5)	74.0
35–39	23.0	19.4	18.6 (17.1, 20.0)	3.6 (3.3, 3.9)	1.3 (1.3, 1.3)	36.4	2.3 (2.0, 2.5)	63.6
40–44	29.5	23.7	24.2 (22.8, 25.6)	5.7 (5.4, 6.0)	2.3 (2.2, 2.4)	40.0	3.4 (3.1, 3.7)	60.0
45–49	41.1	34.4	19.6 (18.5, 20.7)	6.7 (6.4, 7.1)	3.9 (3.9, 4.0)	58.3	2.8 (2.5, 3.2)	41.7
50–54	60.6	50.2	20.8 (20.0, 21.7)	10.4 (10.0, 10.8)	6.0 (5.9, 6.1)	57.6	4.4 (4.0, 4.8)	42.4
55–59	89.3	77.4	15.3 (14.6, 15.9)	11.8 (11.3, 12.3)	9.1 (8.9, 9.2)	76.6	2.8 (2.3, 3.3)	23.4
60–64	128.3	110.9	15.7 (15.1, 16.3)	17.4 (16.8, 18.0)	14.1 (13.9, 14.2)	81.1	3.3 (2.7, 3.9)	18.9
65–69	178.9	152.0	17.7 (17.2, 18.3)	26.9 (26.1, 27.7)	21.6 (21.4, 21.8)	80.4	5.3 (4.5, 6.1)	19.6
70–74	258.1	222.5	16.0 (15.5, 16.5)	35.5 (34.5, 36.6)	33.0 (32.8, 33.3)	93.0	2.5 (1.4, 3.6)	7.0
75–79	414.1	358.1	15.7 (15.2, 16.1)	56.1 (54.9, 57.7)	55.1 (54.6, 55.5)	98.2	1.0 (0.0, 2.6)	1.8
80–84	754.1	648.1	16.4 (15.9, 16.8)	106.0 (103.8, 108.5)	103.8 (103.1, 104.4)	97.9	2.2 (0.0, 4.8)	2.1
≥ 85	1403.0	1240.4	13.1 (12.8, 13.4)	180.8 (179.8, 181.8)	180.8 (179.8, 181.8)	100.0	0.0 (0.0, 0.0)	0.0
By race/ethnicity								
White	128.0	114.4	11.9 (11.7, 12.1)	13.6 (13.4, 13.8)	12.1 (12.1, 12.2)	89.2	1.5 (1.2, 1.7)	10.8
Black	110.5	88.3	25.2 (24.6, 25.7)	22.2 (21.8, 22.6)	15.2 (15.0, 15.3)	68.2	7.1 (6.6, 7.5)	31.8
Hispanic	51.1	37.3	37.0 (36.2, 37.8)	13.8 (13.6, 14.1)	11.6 (11.5, 11.7)	84.0	2.2 (1.9, 2.5)	16.0
Asian	48.6	40.0	21.6 (20.4, 22.8)	8.6 (8.2, 9.1)	7.3 (7.2, 7.4)	84.4	1.3 (0.9, 1.8)	15.6
AIAN	102.8	77.6	32.5 (30.0, 35.1)	25.2 (23.5, 26.9)	19.3 (18.8, 19.9)	76.6	5.9 (4.1, 7.7)	23.4
NHPI	75.4	63.0	19.7 (14.6, 25.3)	12.4 (11.3, 15.5)	11.8 (10.9, 12.7)	95.3	0.6 (0.0, 3.8)	4.7
By age and race/ethnicity								
0–29 y								
White	7.4	6.6	12.5 (11.1, 14.0)	0.8 (0.7, 0.9)	0.1 (0.1, 0.1)	8.4	0.8 (0.7, 0.8)	91.6
Black	15.3	12.4	23.3 (21.0, 25.5)	2.9 (2.6, 3.1)	0.3 (0.3, 0.3)	9.5	2.6 (2.4, 2.9)	90.5
Hispanic	6.9	5.9	16.6 (14.2, 19.0)	1.0 (0.8, 1.1)	0.3 (0.2, 0.3)	26.7	0.7 (0.6, 0.8)	73.3

Continued

TABLE 1— Continued

	Observed Risk of Death (O), Deaths per 10 000 Population	Expected Risk of Death (E), Deaths per 10 000 Population	Increase in the Risk of Death, (O–E)/E, % (95% CI)	Excess Risk of Death From All Causes, Deaths per 10 000 Population (95% CI)	Excess Risk of Death Directly Attributed to COVID-19		Excess Risk of Death Indirectly Attributable to the Pandemic	
					Deaths per 10 000 Population (95% CI)	% of All Excess Deaths	Deaths per 10 000 Population (95% CI)	% of All Excess Deaths
Asian	3.5	3.5	−0.2 (−5.7, 5.7)	0.1 (0.1, 0.2)	0.1 (0.1, 0.1)	. . .[a]	0.0 (0.0, 0.1)	. . .[a]
AIAN	16.2	13.0	24.4 (15.8, 33.3)	3.2 (2.1, 4.2)	0.7 (0.6, 0.9)	23.5	2.4 (1.4, 3.4)	76.5
NHPI	11.6	11.7	−0.5 (−15.5, 17.8)	0.9 (0.6, 1.9)	0.9 (0.6, 1.3)	100.0	0.0 (0.0, 1.0)	0.0
30–49 y								
White	27.6	23.4	18.1 (17.2, 19.1)	4.2 (4.0, 4.4)	0.8 (0.8, 0.9)	20.0	3.4 (3.2, 3.6)	80.0
Black	44.7	34.3	30.4 (28.6, 32.2)	10.4 (9.9, 10.9)	3.7 (3.6, 3.8)	35.9	6.7 (6.1, 7.2)	64.1
Hispanic	22.2	15.7	41.2 (39.0, 43.5)	6.5 (6.2, 6.8)	4.3 (4.2, 4.4)	66.8	2.1 (1.8, 2.5)	33.2
Asian	9.3	7.6	23.1 (18.5, 28.1)	1.8 (1.4, 2.1)	1.0 (1.0, 1.1)	59.7	0.7 (0.4, 1.0)	40.3
AIAN	71.2	49.7	43.3 (36.8, 50.4)	21.5 (18.8, 24.3)	9.7 (8.9, 10.4)	44.9	11.9 (9.0, 14.7)	55.1
NHPI	40.3	30.2	33.4 (18.5, 49.5)	10.1 (6.5, 14.0)	6.4 (5.3, 7.5)	63.4	3.7 (0.0, 7.7)	36.6
50–69 y								
White	109.0	95.0	14.7 (14.3, 15.2)	14.0 (13.6, 14.4)	7.7 (7.6, 7.8)	55.1	6.3 (5.9, 6.7)	44.9
Black	173.0	138.0	25.4 (24.5, 26.3)	35.1 (33.9, 36.2)	23.9 (23.6, 24.2)	68.1	11.2 (10.0, 12.3)	31.9
Hispanic	93.6	62.4	50.1 (48.6, 51.7)	31.3 (30.5, 32.0)	26.8 (26.5, 27.1)	85.7	4.5 (3.6, 5.3)	14.3
Asian	51.5	40.2	28.2 (25.6, 30.9)	11.4 (10.4, 12.3)	9.1 (8.8, 9.3)	79.8	2.3 (1.3, 3.3)	20.2
AIAN	162.9	121.0	34.6 (30.3, 39.0)	41.9 (37.4, 46.3)	34.2 (32.7, 35.7)	81.6	7.7 (2.9, 12.4)	18.4
NHPI	147.0	116.5	26.1 (17.4, 35.3)	30.4 (26.4, 39.6)	28.0 (25.2, 31.0)	92.1	2.4 (0.0, 11.9)	7.9
≥ 70 y								
White	604.7	548.2	10.3 (10.1, 10.6)	68.7 (68.4, 69.0)	68.7 (68.4, 69.0)	100.0	0.0 (0.0, 0.0)	0.0
Black	670.7	543.5	23.4 (22.7, 24.2)	127.2 (123.5, 131.0)	112.7 (111.5, 113.8)	88.6	14.6 (10.7, 18.4)	11.4
Hispanic	509.2	387.1	31.5 (30.5, 32.5)	122.1 (118.7, 125.4)	116.7 (115.5, 117.9)	95.6	5.4 (1.9, 8.9)	4.4
Asian	368.6	307.1	20.0 (18.6, 21.4)	61.5 (57.5, 65.4)	55.9 (54.8, 57.1)	91.0	5.5 (1.3, 9.7)	9.0
AIAN	501.6	393.9	27.4 (23.5, 31.2)	111.1 (107.4, 121.1)	111.1 (106.6, 115.8)	100.0	0.0 (0.0, 10.6)	0.0
NHPI	428.0	380.5	12.5 (4.8, 20.6)	58.7 (52.1, 75.5)	58.7 (51.4, 66.4)	100.0	0.0 (0.0, 18.3)	0.0

Note. AIAN = American Indian or Alaska Native; CI = confidence interval; NHPI = Native Hawaiian or Pacific Islander. Calculated using provisional death data last updated on August 1, 2021.

[a] Proportions of excess deaths were not calculated when total excess deaths were fewer than 1 in 100 000.

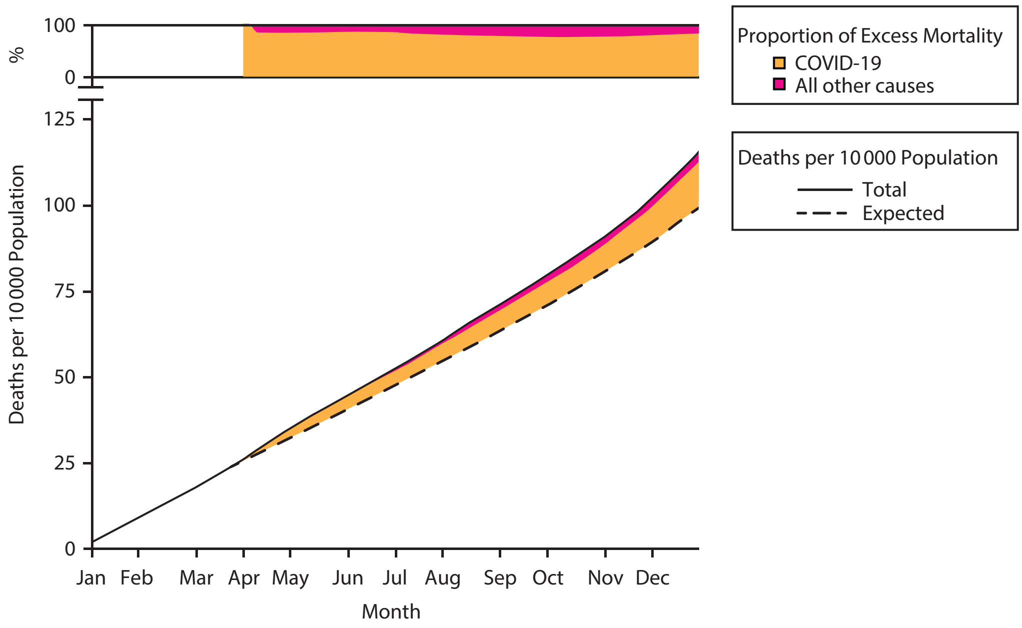

FIGURE 1— US Excess Mortality Directly Attributed to COVID-19 and From All Other Causes in 2020

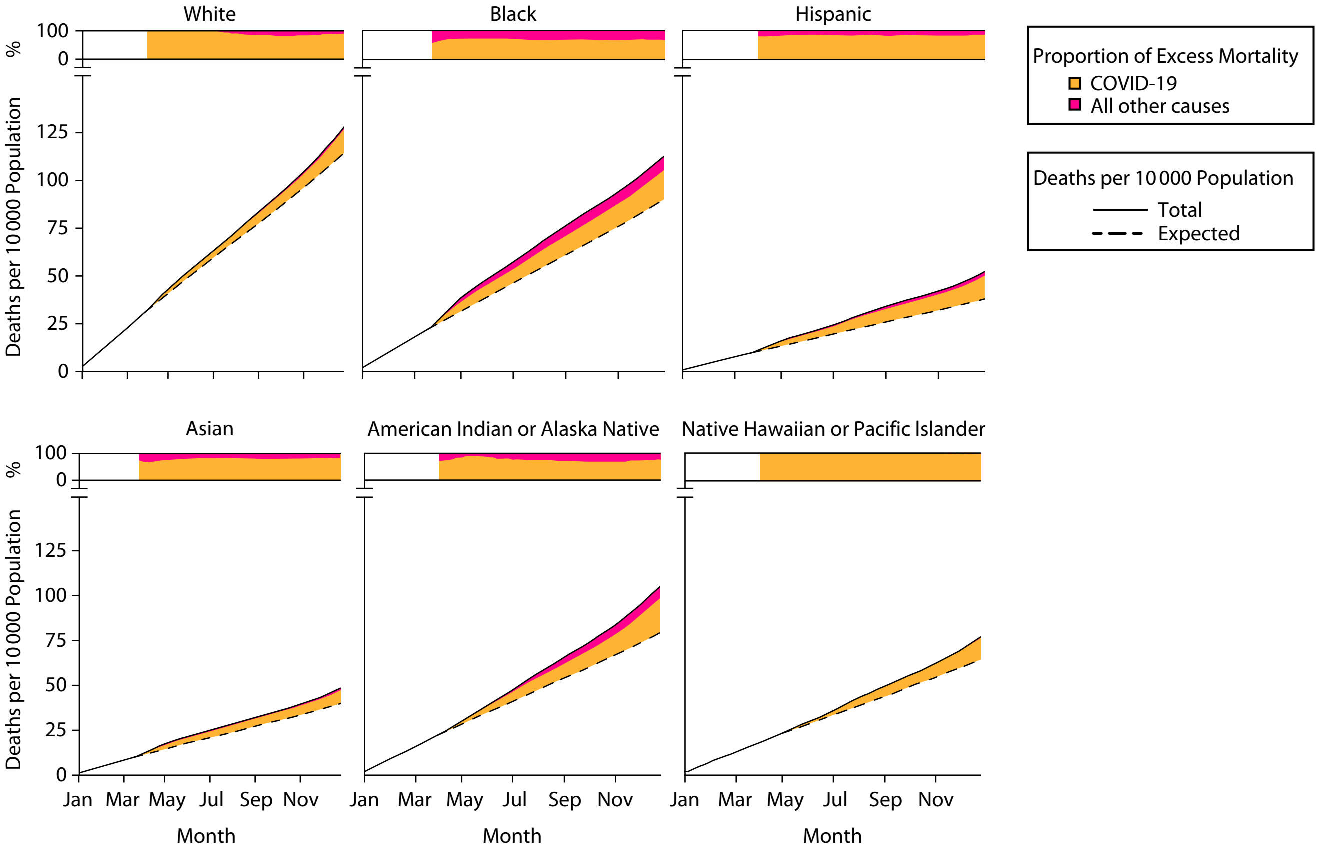

FIGURE 2— US Excess Mortality Directly Attributed to COVID-19 and From All Other Causes in 2020, by Race/Ethnicity

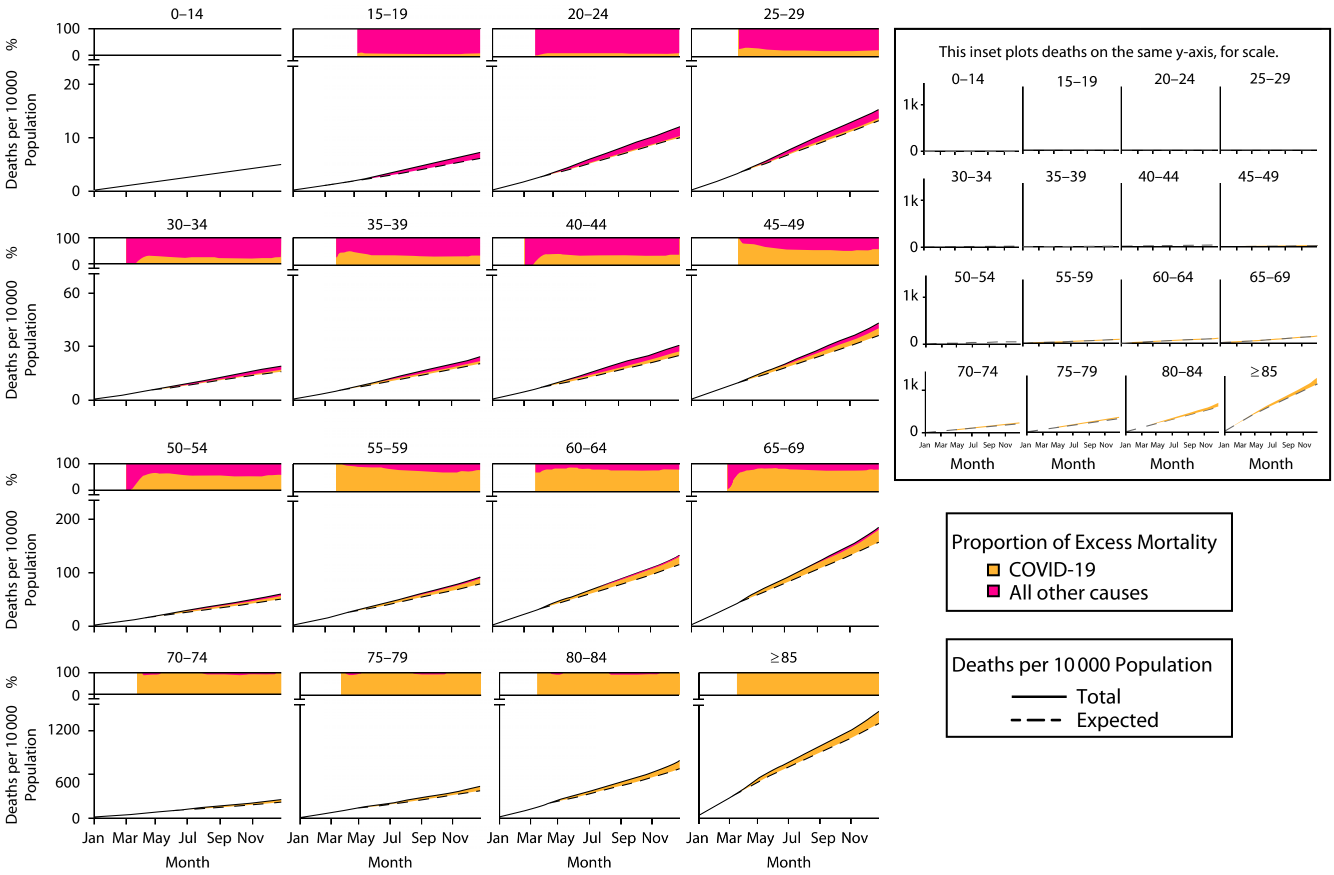

FIGURE 3— US Excess Mortality Directly Attributed to COVID-19 and From All Other Causes in 2020, by Age Group

largely driven by differences in the age distributions of different racial/ethnic groups. For example, the expected risk of death among Hispanic Americans (37.3 deaths per 10 000) was a fraction of the expected risk of death among non-Hispanic White Americans (114.4 deaths per 10 000). Comparisons of the percentage increase in observed versus expected mortality account for differences in prepandemic mortality patterns. For example, decedents identified as non-Hispanic White experienced an 11.9% increase in observed versus expected mortality in 2020 (95% CI = 11.7%, 12.1%), whereas decedents identified as Hispanic experienced a 37.0% increase (95% CI = 36.2%, 37.8%)—more than 3 times the increase experienced by White Americans. The percentage increase in observed versus expected mortality was 32.5% among decedents identified as American Indian or Alaska Native (95% CI = 30.0%, 35.1%), 25.2% among those identified as Black (95% CI = 24.6%, 25.7%), 21.6% among those identified as Asian (95% CI = 20.4%, 22.8%), and 19.7% among those identified as Native Hawaiian or Pacific Islander (95% CI = 14.6%, 25.3%).

The proportion of excess deaths directly attributed to COVID-19 also varied substantially across racial/ethnic groups. Deaths indirectly attributable to the pandemic accounted for as much as 32% of excess mortality among decedents identified as Black and as little as 5% of excess mortality among those identified as Native Hawaiian or Pacific Islander. When considering younger age groups (ages 0–29, 30–49, and 50–69 years), the proportion of excess mortality indirectly attributable to the pandemic was highest among decedents identified as White (Appendix, Figure A). In these younger age groups, however, the absolute risks of death indirectly attributable to the pandemic were greatest among decedents identified as Black and American Indian or Alaska Native. Among adults aged 30 to 49 years, for example, indirect causes accounted for 6.7 deaths per 10 000 Black decedents aged 30 to 49 years and 11.9 deaths per 10 000 American Indian or Alaska Native decedents aged 30 to 49 years, versus 3.4 deaths per 10 000 White decedents aged 30 to 49 years.

DISCUSSION

We estimate that there were nearly 17 excess pandemic-related deaths in 2020 per 10 000 US residents alive on January 1, 2020. This is an estimate of the net effect of the pandemic on mortality. The net effect accounts for deaths caused by and prevented by the pandemic (i.e., some portion of deaths caused by the pandemic is offset by decreases in influenza deaths, traffic fatalities, and other deaths that would have occurred in the absence of lockdowns and social distancing). We estimate that 84% of excess deaths were directly attributed to COVID-19, while the remaining 16% of excess deaths represent the net indirect effect of the pandemic on mortality in 2020.

Our estimate of excess deaths directly attributable to COVID-19 exceeds an earlier estimate of 66% based on data through October 2020[1] and a more recent estimate of 72% that did not account for delays in the reporting of death certificates to the NCHS.[2] Both earlier estimates were also based on mortality rates, which, unlike risks, do not account for changes in the population denominator as more susceptible individuals die and less susceptible individuals are born into the population, or as individuals age in and out of groups with different mortality risks. In group-specific analyses, we found that the proportion of excess deaths indirectly attributable to the pandemic varied widely by age, and across racial/ethnic groups within strata of age. Our findings reveal that a substantial proportion of pandemic-related mortality has not been captured in surveillance data on deaths from COVID-19, particularly among young people who are not recognized as being at serious risk of death from COVID-19. We also found that racial/ethnic inequities in pandemic-related mortality are likely underestimated when only deaths directly attributed to COVID-19 are considered.

Underdiagnosis of COVID-19 may explain part of the difference between excess deaths and deaths directly attributed to COVID-19. Underdiagnosis is an especially plausible explanation for deaths occurring early in the pandemic period, when testing was not yet widespread, and before the release of federal guidelines for reporting COVID-19 deaths on March 24, 2020.[12] These guidelines give some leeway to coroners and medical examiners, who are responsible for confirming cause of death, and it is possible that some have systematically underreported deaths from COVID-19.[13] Underdiagnosis is unlikely to account for all excess deaths during the pandemic period, however. In the United Kingdom, hospital autopsies conducted during the first 2 months of lockdown (starting on March 23, 2020) identified reduced access to health care, financial and work pressures, and drug and alcohol misuse as much more frequent causes of death than undiagnosed COVID-19.[14] In the United States, documented increases in deaths from chronic diseases like dementia, diabetes, and heart disease[9,15] may partially reflect underdiagnosed COVID-19, but they may also, along with increases in deaths from drug overdose[15,16] and homicide,[17] reflect the sweeping social and economic costs of the pandemic.[18] Future validation studies may illuminate what proportion of excess deaths may have been attributable to undiagnosed COVID-19.

In our analysis, we found that excess deaths among older adults were much more likely to be directly attributed to COVID-19 than deaths among people aged younger than 55 years. Our results corroborate a previous study that found that only 38% of excess deaths among adults aged 25 to 44 years from March to July 2020 were directly attributed to COVID-19.[19] Inadequate testing among young adults early in the pandemic may have contributed to the low proportion of deaths directly attributed to COVID-19 in this group, although access to testing has since improved. Another plausible explanation is that, while young adults are less susceptible to COVID-19, they are nonetheless dying at alarming rates because of the social and economic effects of the pandemic. For example, school closures and stay-at-home orders have isolated many young adults from their daily activities and social support systems, leading to increases in suicidal ideation and attempts.[20] Young working adults are more likely than older working adults to have lost jobs, be underemployed, and be excluded from economic assistance programs,[21] resulting in serious physical and mental health harms.[22] Whatever the mechanisms linking the pandemic to increases in mortality among young people, it is clear that total pandemic-related mortality in this group is substantially and systematically underestimated in statistics describing deaths from COVID-19.

In addition to differences by age group, the proportion of excess deaths directly attributed to COVID-19 varied substantially across racial/ethnic groups, from 95% among decedents identified as Native Hawaiian or Pacific Islander to only 68% among decedents identified as Black. Our findings corroborate a recent ecological study by Stokes et al., which found that counties with more Black residents had lower proportions of excess deaths attributed to COVID-19,[23] and a study by Wrigley-Field et al., which found that racial disparities in excess deaths were greater than racial disparities in deaths attributed to COVID-19 in Minnesota.[24] Because the proportion of deaths attributed to COVID-19 was lower in many of the same racial/ethnic groups that experienced disproportionate increases in mortality in 2020, racial/ethnic disparities in pandemic-related mortality are likely to be underestimated in analyses that only consider deaths directly attributed to COVID-19.

One explanation for the lower proportion of excess deaths attributed to COVID-19 among many racially minoritized groups may be inequitable access to testing, resulting in higher rates of undiagnosed COVID-19.[25] However, the indirect effects of the pandemic are also likely to be greater among racially minoritized groups because the social and economic impacts of the pandemic have not been uniformly distributed. For example, as a consequence of racial capitalism, Black and Latinx workers are more likely to suffer the physical and mental health consequences of losing jobs, employment benefits, and savings during the pandemic recession, or working in sectors that place them at higher risk of exposure to SARS-CoV-2.[26,27] Asian Americans have suffered discrimination and violence as a result of racist narratives about the origins of COVID-19.[28] The distributions of these pandemic-related stressors, like the distribution of infections, reflect the pre-existing social context.[8,29–31]

Historically, marginalized communities have often been disproportionately affected by public health emergencies, from past pandemics to Hurricane Katrina and the Flint water crisis. History has shown us that the effects of such emergencies play out long after the acute threat has passed, exacerbating pre-existing inequities.[32] The financial burden of the pandemic, for example, has fallen disproportionately on hourly workers and small business owners, compounding the economic disparities that existed before the pandemic.[33] These same economically marginalized communities are often communities of color who, as Cooper and Williams explained in a recent commentary, "have borne the burden of excess deaths from health disparities for generations."[33(p1491)]

Accurate estimates of the full scale of pandemic-related mortality in specific population groups are critical to guide the efficient and equitable allocation of resources for the pandemic response. For example, the prioritization and allocation of resources to support safe school reopening should be informed by comprehensive data on how the pandemic affects the health of adolescents, including their mental health. Attribution of excess deaths to the pandemic may also have tangible consequences for families and communities, allowing access to funeral assistance and other funding allocated for disaster relief.[34] Moreover, accurate estimates of disparities are needed to expose unjust social structures as a first step toward restorative justice and healing.[33] Finally, our finding that the net effect of the pandemic on mortality was consistently underestimated in certain groups reveals an urgent need to improve our national surveillance systems. If these systems are not designed with health equity in mind, they will continue to downplay the effects of emerging pathogens on marginalized groups.[35]

Limitations

Deaths tend to follow a highly regular seasonal pattern, and mortality data are often more complete than diagnostic data, making excess deaths a revealing indicator of the population health impacts of the pandemic. Nevertheless, interpretation of our findings relies on the assumptions stated in the Methods section. For example, we assumed that people who died of COVID-19 would not have died absent the pandemic. Some people who died of COVID-19 in 2020, particularly adults in the oldest age group, may have died regardless of the pandemic, albeit from different causes. Also, while we modeled expected deaths flexibly, we may have underestimated expected deaths because of recent demographic trends or increases in causes of death unrelated to the pandemic, or overestimated expected deaths because of our linear parameterization of epidemiological year. Finally, self-described race/ethnicity may be misclassified on death certificates, and risks may be slightly underestimated because of missing data on race/ethnicity (0.74% of all deaths in 2020) and overestimated because of deaths among foreign residents (0.2%).

Public Health Implications

Accurate estimates of pandemic-related mortality are essential in guiding an efficient and equitable public health response to COVID-19. The net effect of the pandemic on mortality, and on population disparities in mortality, appears to be severely underestimated when only counting deaths directly attributed to COVID-19. Given differences among racial/ethnic groups in the proportion of excess mortality directly attributed to COVID-19, pandemic response efforts and policies that consider only the biological effects of the pandemic are likely to exacerbate health inequities that existed before 2020. AJPH

ABOUT THE AUTHORS

The authors are with the Department of Epidemiology, University of North Carolina at Chapel Hill.

CORRESPONDENCE

Correspondence should be sent to Lauren Zalla, Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, CB#7435, Chapel Hill, NC 27599 (e-mail: zalla@unc.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

L. C. Zalla conceptualized the study, conducted the analysis, and drafted the article. J. K. Edwards, G. E. Mulholland, and L. M. Filiatreau provided input on the analysis and revised the article.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

HUMAN PARTICIPANT PROTECTION

This study used publicly available data and was determined to not be human participant research by the institutional review board at the University of North Carolina at Chapel Hill.

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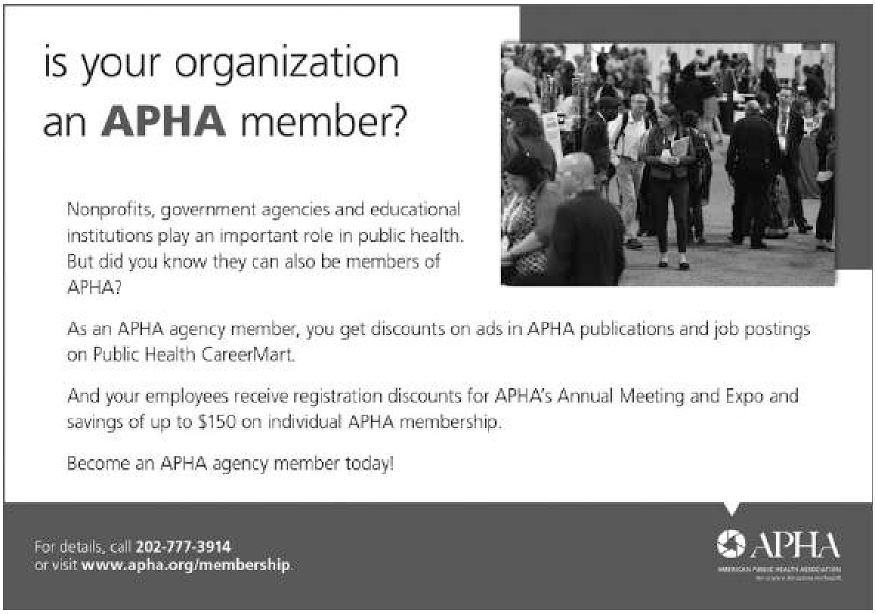

Deviation in the Age Structure of Mortality as an Indicator of COVID-19 Pandemic Severity

Siddharth Chandra, PhD, and Madhur Chandra, PhD

Objectives. To test whether distortions in the age distribution of deaths can track pandemic activity.

Methods. We compared weekly distributions of all-cause deaths by age during the COVID-19 pandemic in the United States from March to December 2020 with corresponding prepandemic weekly baseline distributions derived from data for 2015 to 2019. We measured distortions via Kolmogorov–Smirnov (K-S) and χ^2 goodness-of-fit statistics as well as deaths among individuals aged 65 years or older as a percentage of total deaths (PERC65+). We computed bivariate correlations between these measures and the number of recorded COVID-19 deaths for the corresponding weeks.

Results. Elevated COVID-19-associated fatalities were accompanied by greater distortions in the age structure of mortality. Distortions in the age distribution of weekly US COVID-19 deaths in 2020 relative to earlier years were highly correlated with COVID fatalities (K-S: $r = 0.71$, $P < .001$; χ^2: $r = 0.90$, $P < .001$; PERC65+: $r = 0.85$, $P < .001$).

Conclusions. A population-representative sample of age-at-death data can serve as a useful means of pandemic activity surveillance when precise cause-of-death data are incomplete, inaccurate, or unavailable, as is often the case in low-resource environments. (*Am J Public Health*. 2022;112(1):165–168. https://doi.org/10.2105/AJPH.2021.306567)

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Pandemic activity is difficult to measure in low-resource environments because diagnostic testing and cause-of-death data are often unavailable, inaccurate, or incomplete.[1,2] In the absence of such data, age-at-death data can reveal possible pandemic activity because pandemics often have signature age–mortality profiles. A recent study on the 1918 influenza pandemic in Michigan showed a high correlation ($r = 0.83$) between pandemic activity, measured by excess deaths, and distortions in the age distribution of fatalities, measured via a goodness-of-fit statistic.[3] The ongoing COVID-19 pandemic also has a marked age–mortality profile, with a high concentration of deaths among elderly populations. Our aim in this study was to examine whether age-at-death data can be used to track COVID-19 pandemic activity.

To test this proposition, we compared weekly distributions of all-cause deaths by age during the COVID-19 pandemic in the United States during March to December 2020 with corresponding prepandemic weekly baseline distributions derived from 2015 to 2019 data. Distortion of these weekly distributions during the COVID-19 pandemic relative to the corresponding baseline distributions was measured via Kolmogorov–Smirnov (K-S) and χ^2 goodness-of-fit statistics,[4] which were then compared with the number of recorded COVID-19 deaths during the corresponding weeks via bivariate correlations .

Also, we used a bivariate correlation to compare a much simpler measure of distortion, weekly deaths among individuals aged 65 years or older as a percentage of total deaths (PERC65+), with weekly COVID-19 fatalities. A key finding was that elevated COVID-19-associated fatalities were accompanied by greater distortions in the age structure of mortality as measured by the K-S and χ^2 statistics and the PERC65+ variable. The main implication of this finding is that a population-representative sample of age-at-death data can serve as a useful measure of pandemic activity when precise diagnostic testing or cause-of-death data are incomplete, inaccurate, or unavailable, as is often the case in low-resource environments.

METHODS

We obtained US weekly all-cause mortality data for the period 2015 to 2020 by age from the National Center for Health Statistics.[5] The age categories were younger than 25 years, 25 to 44 years, 45 to 64 years, 65 to 74 years, 75 to 84 years, and 85 years or older. Weekly national COVID-19 fatality data for 2020 were also obtained from the National Center for Health Statistics.[6]

Weekly numbers of all-cause deaths by age for the 5 years preceding 2020 (i.e., 2015–2019) were aggregated across the years to create a baseline distribution of weekly all-cause deaths. The age distributions of all-cause mortality for weeks 13 (March 15 through 21, 2020) to 53 (December 27, 2020, through January 2, 2021), corresponding to the period after which reported weekly COVID-19 fatalities first exceeded 1000, were compared with the baseline distributions for the corresponding weeks of 2015 to 2019 via the K-S and χ^2 goodness-of-fit statistics. We used bivariate correlations to compare these statistics, which measure the distortion of the age distribution of deaths for each week relative to the baseline as well as the weekly share of fatalities among individuals aged 65 years or older as a percentage of all fatalities, with the reported number of deaths from COVID-19 for the corresponding week. SAS version 9.4 was used in all calculations.[7]

RESULTS

Parts a and b of Figure 1 show K-S and χ^2 statistics as well as reported COVID-19 deaths for the 41 weeks in the sample. Both series demonstrate a robust degree of correlation with COVID-19 fatalities (K-S: $r = 0.71$, $P < .001$; χ^2: $r = 0.90$, $P < .001$; see also Figure A, available as a supplement to the online version of this article at http://www.ajph.org). Part c of Figure 1 shows weekly deaths among people aged 65 years or older as a percentage of all deaths and reported COVID-19 deaths for the corresponding weeks. Again, the correlation is high ($r = 0.85$; $P < .001$; see also Figure A).

Table A (available as a supplement to the online version of this article at http://www.ajph.org) shows the distribution of all-cause deaths by age during the baseline weeks and corresponding weeks in 2020 when COVID activity was at or near a local peak. This table demonstrates that the COVID-19 pandemic was marked by a disproportionately high share of deaths among individuals 65 to 74 and 75 to 84 years of age relative to the prepandemic baseline (percentages in shaded dark gray cells) and a disproportionately low share of deaths among individuals younger than 25 years and 45 to 64 years of age (percentages in shaded light gray cells).

Finally, Figure B (available as a supplement to the online version of this article at http://www.ajph.org) shows K-S statistics for distortions in the age distribution of fatalities in the pandemic-free year 2019 with 2015 through 2018 as the baseline. This figure reveals a pattern of smaller and more stable distortions than does the graph for the corresponding weeks in 2020 when pandemic activity was high.

DISCUSSION

Our analysis demonstrates the presence of a COVID-19 “signature” in a population-representative sample of data on the age distribution of US all-cause mortality during the COVID-19 pandemic. It has been noted elsewhere that, in 2020, there were large variations in COVID-19 activity across countries around the world.[8,9] Proposed reasons for this observation include variations in (1) imposition of gathering restrictions, (2) climatic conditions,[9,10] (3) the prevalence of complicating comorbid conditions,[11] (4) immune system priming,[12] and (5) the quality and coverage of public health surveillance. To the extent that some of the reported differentials may be the result of more accurate surveillance mechanisms in well-resourced systems, using distortions in the age structure of mortality as a proxy for pandemic activity may help shed light on pandemic activity in less well-resourced environments.

Limitations

The strategy proposed here involves making indirect inferences about pandemic activity using age-at-death data. Therefore, population-representative data on age at death are necessary, along with the known occurrence of an ongoing pandemic and the absence of other confounding phenomena. Absent such triangulating information, distortions in the distribution of fatalities across age groups could have alternate causes and be incorrectly attributed to COVID-19 (see the Appendix, available as a supplement to the online version of this article at http://www.ajph.org).

In addition, although age-at-death or other lagged age-stratified data may be the most appropriate data available for

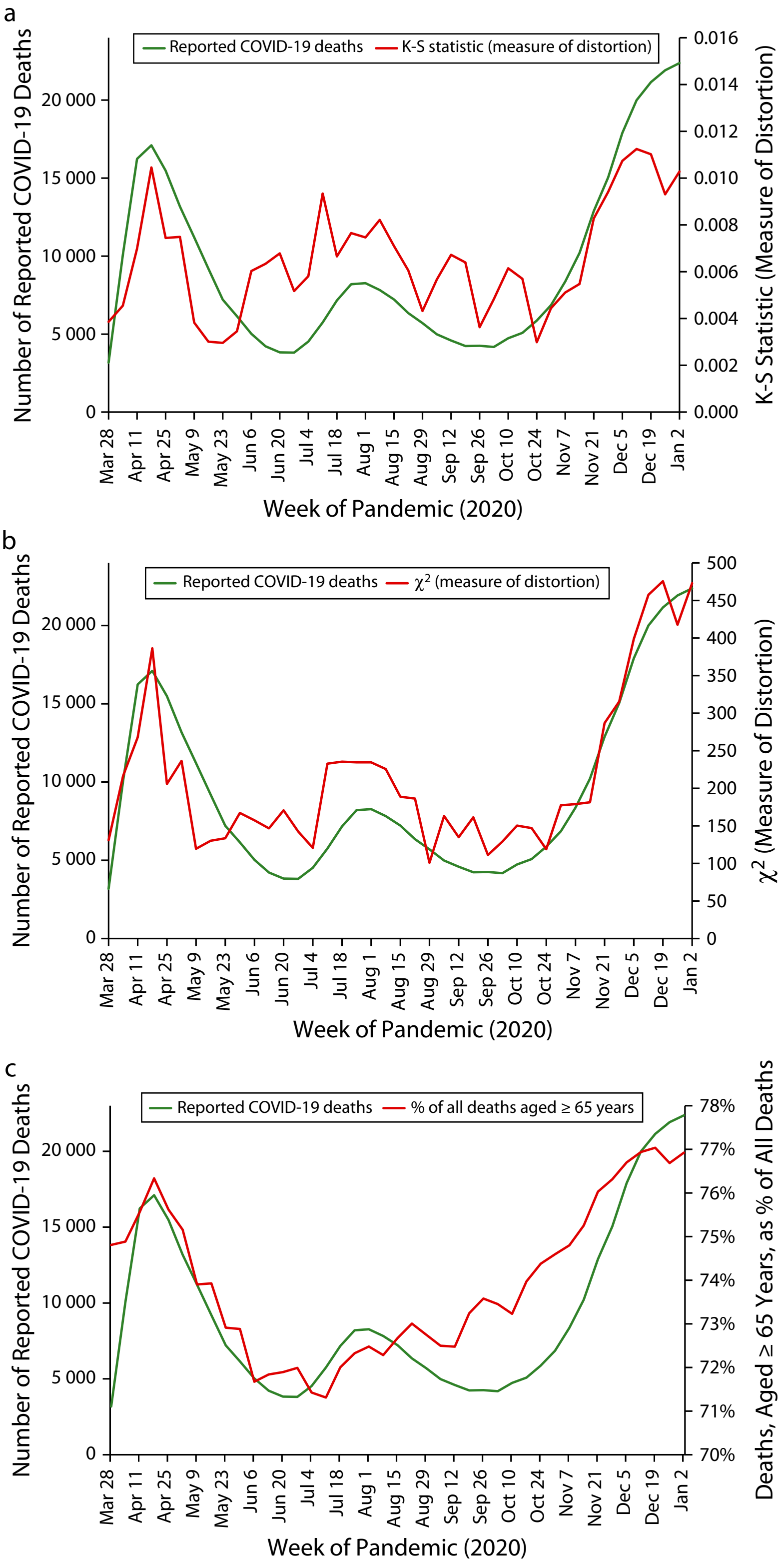

FIGURE 1— **Time Series of Weekly US COVID-19 Deaths vs (a) the Kolmogorov–Smirnov (K-S) Statistic, (b) the χ^2 Goodness-of-Fit Statistic, and (c) Deaths Among Individuals Aged 65 Years or Older as a Percentage of Total Deaths: March 15, 2020, to January 2, 2021**

tracking a pandemic in some contexts (because deaths lag cases),[1,2] they remain retrospective in nature. The only way to overcome such a limitation would be to have accurate diagnostic data in real time, which is, unfortunately, all too often not possible. Finally, we focused on the prevaccine and prevariant stage of the pandemic. A study focusing on how age distortions change with vaccinations and variants, and how the metrics proposed here should be adjusted to capture those changes, would be interesting and potentially useful.

Conclusions

Our study demonstrates a strong correlation between the age structure of mortality and COVID-19 pandemic activity in the United States in 2020. Given the difficulty of accurately tracking pandemics in countries where public health systems lack real-time diagnostic capability, our results show that pandemic activity can be tracked via samples of age-at-death data, which are likely much easier to collect than diagnostic data. Equally interesting is our finding that, although the χ^2 goodness-of-fit statistic displayed the highest correlation with COVID-19 deaths ($r = 0.90$), the simplest measure of distortion, PERC65+, was more highly correlated ($r = 0.85$) than the K-S statistic ($r = 0.71$). Given the ease with which this measure can be computed, its use as a pandemic surveillance tool of first resort (lagged as it may be) in public health systems with limited real-time diagnostic capability merits consideration. AJPH

ABOUT THE AUTHORS

Siddharth Chandra is with the Asian Studies Center and James Madison College, Michigan State University, East Lansing. Madhur Chandra is with

the Ingham County Health Department, Lansing, MI, and the Department of Epidemiology and Biostatistics, Michigan State University.

CORRESPONDENCE

Correspondence should be sent to Siddharth Chandra, PhD, 427 North Shaw Ln, Room 301, Michigan State University, East Lansing, MI 48824 (e-mail: chandr45@msu.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

Siddharth Chandra conceived and designed the project, collected and analyzed the data, interpreted the results, and co-wrote all sections of the article. Madhur Chandra interpreted the results, co-wrote some of the sections of the article, and provided input into all other sections.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

No protocol approval was needed for this study because no human participants were involved.

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Adherence to Social-Distancing and Personal Hygiene Behavior Guidelines and Risk of COVID-19 Diagnosis: Evidence From the Understanding America Study

Theresa Andrasfay, PhD, Qiao Wu, MIPM, Haena Lee, PhD, and Eileen M. Crimmins, PhD

Objectives. To assess the association between individual-level adherence to social-distancing and personal hygiene behaviors recommended by public health experts and subsequent risk of COVID-19 diagnosis in the United States.

Methods. Data are from waves 7 through 26 (June 10, 2020–April 26, 2021) of the Understanding America Study COVID-19 survey. We used Cox models to assess the relationship between engaging in behaviors considered high risk and risk of COVID-19 diagnosis.

Results. Individuals engaging in behaviors indicating lack of adherence to social-distancing guidelines, especially those related to large gatherings or public interactions, had a significantly higher risk of COVID-19 diagnosis than did those who did not engage in these behaviors. Each additional risk behavior was associated with a 9% higher risk of COVID-19 diagnosis (hazard ratio [HR] = 1.09; 95% confidence interval [CI] = 1.05, 1.13). Results were similar after adjustment for sociodemographic characteristics and local infection rates.

Conclusions. Personal mitigation behaviors appear to influence the risk of COVID-19, even in the presence of social factors related to infection risk.

Public Health Implications. Our findings emphasize the importance of individual behaviors for preventing COVID-19, which may be relevant in contexts with low vaccination. (*Am J Public Health*. 2022; 112(1):169–178. https://doi.org/10.2105/AJPH.2021.306565)

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COVID-19 continues to be a major public health concern in the United States and worldwide. Since its recognition in late 2019 through August 2021, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has infected more than 215 million individuals globally, with more than 39 million cases in the United States alone.[1] These cases have resulted in an enormous mortality toll: COVID-19 was the third-leading cause of death in the United States in 2020, and it reduced 2020 US life expectancy by more than a year.[2,3] At the time of writing (August 2021), many areas of the United States are experiencing surges of cases fueled by the highly transmissible Delta variant, and the Centers for Disease Control and Prevention (CDC) has revised its guidance to again recommend indoor masking for all individuals in high-transmission areas, regardless of vaccination status.[4]

Stopping the pandemic still requires using all available tools, including simple behavioral modifications. Government officials and public health experts have been urging people to engage in preventive behaviors, including wearing a mask that covers the nose and mouth, staying 6 feet apart from others, avoiding crowds and poorly ventilated indoor spaces, and washing hands often with soap and water or hand sanitizer.[5]

Empirical evidence has shown that social-distancing and personal hygiene recommendations or mandates at aggregate levels effectively slow the spread of the virus. In the United States, county-level and state-level mask mandates have significantly reduced the growth rates of local COVID-19 cases.[6–10] By the end of 2020, mask mandate policies were found to be associated with significant reductions in the growth rates of county-level daily case numbers and deaths within a month of implementation, as well as reductions in state-level cases.[6,7,9,11] Studies have also found that other nonpharmaceutical policy interventions, such as quarantine of exposed individuals, social distancing, workplace closures, and restrictions on large gatherings and events, help reduce the spread of the virus.[6,8,11–15] For example, reopening restaurant dining increased the growth rates of county-level cases and deaths within 41 to 80 days of reopening.[6] Isolation or quarantine, social distancing, and traffic restriction policies were found to have reduced the reproduction number of the disease by up to 43%.[11] Notably, the stringency of control measures was associated with greater reductions in disease proliferation.[15]

The effectiveness of preventive behaviors undertaken by individuals remains unclear, likely because of limitations of existing data sources. Studies on the topic have primarily been retrospective studies or case–control studies,[16–20] which may be biased by inaccurate recall of past behavior. A recent study linked preventive behaviors to COVID-19 infection using prospective data, but it focused on a limited set of social-distancing behaviors, captured infections through only October 2020, and was based on a sample that may not be widely generalizable.[21] Population-level studies have typically focused on large gatherings or public spaces as sources of exposure to COVID-19, but there has been less evidence about the risk of COVID-19 from smaller gatherings, which were less amenable to policy interventions.[22] Although individuals who repeatedly engage in risky behaviors likely have a higher risk of COVID-19 infection than those who do not, no nationally representative research has examined the cumulative role of individual behaviors in determining the risk of COVID-19 infection.

We addressed these gaps in the literature by using the Understanding America Study (UAS) survey, one of the only nationally representative longitudinal data sources that assess changes in behaviors that affect one's risk of COVID-19 infection over time. We hypothesized that not practicing the recommended social distancing or COVID-19–related personal hygiene behaviors would elevate the risk of COVID-19 infection and that the risk of COVID-19 infection would increase with engagement in additional numbers of risky behaviors.

METHODS

We used data from the UAS, which is conducted by the Center for Economic and Social Research at the University of Southern California. The UAS is a nationally representative Internet panel study of US adults that began in 2014 with the support of the National Institute on Aging, the Social Security Administration, and the Gates Foundation. The UAS uses address-based probability sampling to reduce coverage bias and improve representativeness, and it lends Internet-connected tablets to respondents if needed, which minimizes the effect of the digital divide on this Internet panel.[23] As an already established online panel study, the UAS was able to safely continue data collection during the pandemic and ask participants about their personal experiences with COVID-19, behaviors, and social, psychological, and economic consequences of the pandemic. The UAS COVID-19 longitudinal survey began in March 2020, and subsequent surveys were conducted every 2 weeks through March 2021, at which point the survey became monthly.

For this study, we used data from waves 7 through 26 of the UAS COVID-19 survey, covering the period from June 10, 2020, to April 26, 2021, because these waves consistently asked about the set of COVID-19–related behaviors that we study. Of the 8110 respondents who participated in at least 1 of these waves, we restricted our analysis to individuals who did not report a COVID-19 diagnosis at their first interview in this period, who had at least 1 subsequent wave of follow-up, and who had complete sociodemographic and behavioral information for at least 1 wave (n = 7604). The excluded respondents were younger on average than those included in the sample but were otherwise demographically similar (Table A [available as a supplement to the online version of this article at http://www.ajph.org]). We included all observations of each respondent until COVID-19 diagnosis, receipt of at least 1 dose of a COVID-19 vaccine, loss to follow-up, or the end of our study period (n = 104 677 person-waves over 4769 person-years of follow-up). Although at the time of writing there was considerable attention to breakthrough infections among vaccinated individuals, we chose to censor individuals upon vaccination because during the study follow-up period, breakthrough infections were relatively rare and several of the behaviors analyzed in our study were considered safe for vaccinated individuals.[24]

Measures

The outcome of our study is COVID-19 diagnosis. At each wave, respondents reported whether they had tested positive for COVID-19 or been diagnosed by a health care professional as probably having COVID-19 since their last interview. We considered an affirmative response to either of these questions to be an incident COVID-19 diagnosis. We assigned the date of diagnosis to be the midpoint between the interview date at which the respondent reported having received a COVID-19 diagnosis and their previous interview date.

The predictor variables were a set of time-varying behaviors related to lack of adherence to public health guidance. At each wave in our study period, respondents were asked whether in the previous 7 days they did each of the following: avoided public places, gatherings, or crowds; washed hands with soap or used hand sanitizer several times a day; wore a mask or face covering; avoided eating at restaurants; avoided contact with high-risk people; had visitors at their residence; went to another's residence; went out to a bar, club, or other place where people gather; attended a gathering with more than 10 people; had close contact (within 6 ft) with people not in the household; and attended an in-person religious service. Respondents could answer yes, no, or unsure to each of these behaviors. Because some questions asked about preventive behaviors whereas others asked about risky activities, we recoded some of these so that 1 indicated higher risk and 0 lower risk for each behavior; we coded unsure responses as 1.

To assess how the degree of adherence to public health guidelines was associated with risk of COVID-19 diagnosis, we created a summary index ranging from 0 to 11 that was equal to the count of high-risk behaviors. We also created indicators for 3 categories of risk behaviors indicating any large gathering or public interaction, any small gathering, and any lack of adherence to COVID-19–related personal hygiene guidelines. Details on the question wording for these behaviors and categorizations are provided in Table B (available as a supplement to the online version of this article at http://www.ajph.org).

Demographic covariates included sex, age group at first interview (18–44, 45–64, and ≥ 65 years), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic other), and educational attainment (high school or less, some college, and college or more). To proxy for workplace exposure to COVID-19, we used information on labor force participation and days worked from home in the past 7 days to create a time-varying measure of employment status, which we categorized as working from home; working outside the home; and retired, unemployed, or otherwise out of the labor force. We used information on the age of the respondent's household members, which is updated approximately every 3 months, to create 2 binary indicators of living arrangement: living with working-aged adults (aged 18–64 years; yes = 1) and living with school-aged children (aged < 18 years; yes = 1), because these living arrangements may entail additional exposure through in-person contact with individuals from outside the household.[25,26] As a measure of local infection risk, we included the natural logarithm of the state-level rate of COVID-19 cases over the 7-day period before each interview date; for respondents who did not report a state of residence, we assigned national rates. We obtained COVID-19 case rates from the CDC COVID Data Tracker.[27]

Statistical Analysis

We used Cox hazard models to assess the association between behaviors and risk of COVID-19 diagnosis.[28] These models estimated how observable risk factors multiply a nonparametrically estimated baseline hazard that is shared across all individuals. The clock on these models is time in days since June 10, 2020, which was the first day of our study period. We structured these observations as counting-process data, meaning that for each individual, we partitioned the follow-up period into intervals that started at the interview date and ended at the next interview date or diagnosis date.[28,29] Respondents entered on their first interview date and we considered them at risk until COVID-19 diagnosis, receipt of at least 1 dose of a COVID-19 vaccine, loss to follow-up, or their wave 26 interview date, which was the end of our study period.

We treated risk behaviors as time varying to capture the variation in adherence to behavioral guidelines over the course of the pandemic and to estimate short-term associations between these behaviors and COVID-19. We conducted the Schoenfeld residual test and found no evidence that the proportional hazard assumption was violated.[29] We first fit a set of models assessing the bivariate relationships between the 11 behaviors and the risk of COVID-19. Second, we fit a model predicting COVID-19 from the count of 11 behaviors. Third, we fit a model predicting COVID-19 from the 3 categories of risk behaviors. We have presented both unadjusted results and results adjusted for covariates for each of these models. All analyses included weights provided by the UAS and we conducted all analyses in R version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Characteristics of respondents at their first interview in our study period are displayed in Table 1. We have also presented these characteristics by COVID-19 diagnosis. Approximately 9% (748 respondents) were diagnosed with COVID-19 at some point during the study period; of these cases, 70% were diagnosed with a positive test result. Compared with those who were never diagnosed with COVID-19, those who were diagnosed were on average younger, more likely to be Hispanic, more likely to have lower educational attainment, more likely to work outside the home, and more likely to live with working-aged adults and school-aged children. In terms of behaviors, those ultimately diagnosed with COVID-19 had a greater prevalence of social behaviors and more risk behaviors on average (3.82 vs 3.03) than did those who were never diagnosed. Figure 1 displays the prevalence of each of these behaviors by UAS study wave, revealing that the adherence to behavioral guidelines fluctuated over the course of the study period.

For comparison, the rightmost column of Table 1 displays basic demographic characteristics collected by the CDC for national COVID-19 cases reported through May 13, 2021. The demographic composition of the COVID-19 cases in this study was similar to those of the national COVID-19 cases.

Figure 2 displays the estimated risk of COVID-19 diagnosis since the previous UAS COVID-19 wave along with the case rates reported by the CDC. Our study period of waves 7 through 26 began after the initial surge in cases, and, by contrast with the CDC data, our case data included both positive tests and doctor diagnoses but did not include cases of children younger than 18 years. Despite these differences, the cases identified in the UAS COVID-19 survey displayed the same general temporal pattern as national COVID-19 cases, beginning with the initial wave in spring 2020, a larger wave in summer 2020, and the largest wave of cases in winter 2020 through 2021.

Behavior–Diagnosis Association

Figure 3 displays the hazard ratios (HRs) and 95% confidence intervals (CIs) from the Cox hazard models predicting COVID-19 diagnosis from relevant behaviors. Coefficients from these models are displayed in Table C (available as a supplement to the online version of this article at http://www.ajph.org). With the exception of not avoiding high-risk people, each of the behaviors indicating lack of adherence to social-distancing guidelines was significantly associated with risk of COVID-19 diagnosis in the unadjusted bivariate models. For example, going to a bar, club, or other place where people gather was associated with 64% higher risk of COVID-19 diagnosis before the next interview (HR = 1.64; 95% CI = 1.25, 2.15). Neither hand washing nor face mask wearing were significantly associated with COVID-19 diagnosis in this analysis. The model based on the count of the 11 risk behaviors suggests that each additional risk behavior is associated with 9% greater risk of COVID-19 diagnosis (HR = 1.09; 95% CI = 1.05, 1.13).

Last, the model including categories of risk behaviors together found that engagement in any large gathering or public interaction was more strongly associated with COVID-19 diagnosis (HR = 1.48; 95% CI = 1.20, 1.83) than was engagement in any small gathering (HR = 1.27; 95% CI = 0.97, 1.67; $P < .10$). Lack of adherence to either of the COVID-19–related personal hygiene behaviors was not significantly associated with COVID-19 diagnosis after controlling for social behaviors. When we included sociodemographic covariates and state COVID-19 case rates in these models, associations were generally attenuated but still suggested that individuals who recently engaged in social activities, especially large gatherings, and those who engaged in more total high-risk behaviors had an increased risk of COVID-19 diagnosis.

Supplementary Analyses

In addition to our main specification predicting COVID-19 diagnoses, we considered both stricter and more inclusive case definitions. The stricter case definition included only positive tests. The more inclusive case definition included instances in which respondents believed they had COVID-19 even if they did not get tested to confirm this suspicion, because testing was not

TABLE 1— Summary Statistics of Participants at First Interview: Understanding America Study (UAS), United States, June 10, 2020–April 26, 2021

	Percentage or Mean (SD)			
	Full Sample	Never Diagnosed With COVID-19	Diagnosed With COVID-19 During Follow-Up	CDC COVID-19 Cases
Ever diagnosed with COVID-19	9.3			
Sex				
Female	52.3	51.9	56.4	52.2
Male	47.7	48.1	43.6	47.8
Age, y				
18–44	49.3	49.4	48.4	84.5[a]
45–64	32.1	31.4	38.8	. . .[a]
≥ 65	18.6	19.2	12.8	15.5
Race/ethnicity				
Non-Hispanic White	61.5	62.0	56.4	50.1
Non-Hispanic Black	11.9	12.0	10.7	11.2
Hispanic	17.1	16.4	24.5	29.0
Non-Hispanic other	9.5	9.6	8.4	9.8
Educational attainment				
≤ high school	37.3	37.1	39.1	
Some college	28.4	27.7	34.8	
≥ college	34.3	35.2	26.1	
Employment status				
Working from home	25.9	26.4	21.1	
Working away from home	32.0	31.1	41.1	
Retired, unemployed, or out of labor force	42.1	42.5	37.8	
Living arrangement				
Living with working age adults	67.9	67.3	74.0	
Living with school age children	33.8	33.0	41.3	
State-level cases in past week (per 100 000)	80.19	80.8	74.22	
Behaviors				
Not avoiding public places	29.2	28.3	37.8	
Not washing hands	7.3	7.3	6.6	
Not wearing face mask	14.5	14.6	12.7	
Not avoiding restaurants	34.2	33.2	44.1	
Not avoiding high-risk people	21.1	20.8	24.2	
Having visitors at residence	48.3	47.2	59.1	
Going to another's residence	48.9	47.9	58.8	
Going to a bar, club, etc.	13.1	12.7	16.9	
Attending a gathering with > 10 people	19.5	18.2	32.5	
Contact with non–household members	64.4	63.5	73.2	
Attending religious service in person	9.8	9.1	16.0	
Count of 11 risk behaviors	3.1 (2.41)	3.03 (2.39)	3.82 (2.53)	
Any small gathering	80.3	79.6	87.0	
Any large gathering[b]	51.0	49.7	62.9	

Continued

TABLE 1— Continued

	Percentage or Mean (SD)			
	Full Sample	Never Diagnosed With COVID-19	Diagnosed With COVID-19 During Follow-Up	CDC COVID-19 Cases
Any lack of adherence to personal hygiene behaviors	17.5	17.7	15.7	
No. of respondents	7 604	6 856	748	
No. of observations	104 677	97 602	7 075	
Person-years of follow-up	4 769	4 477	292	

Note. CDC = Centers for Disease Control and Prevention. Percentages and means were based on the first observation of each respondent in this period and were calculated using weights provided by the UAS. State-level cases in the previous week (per 100 000) and CDC COVID-19 cases were from the COVID Data Tracker, updated May 13, 2021.

Source. Data are from the UAS COVID-19 survey waves 7–26.

[a] Indicates combined age group of 18–64 years.

[b] Small gathering includes contact with non–household members, having visitors at residence, going to another’s residence, and not avoiding high-risk people. Large gathering includes going to a bar, club, etc.; attending a gathering with > 10 people; attending religious service in person; not avoiding public places; and not avoiding restaurants.

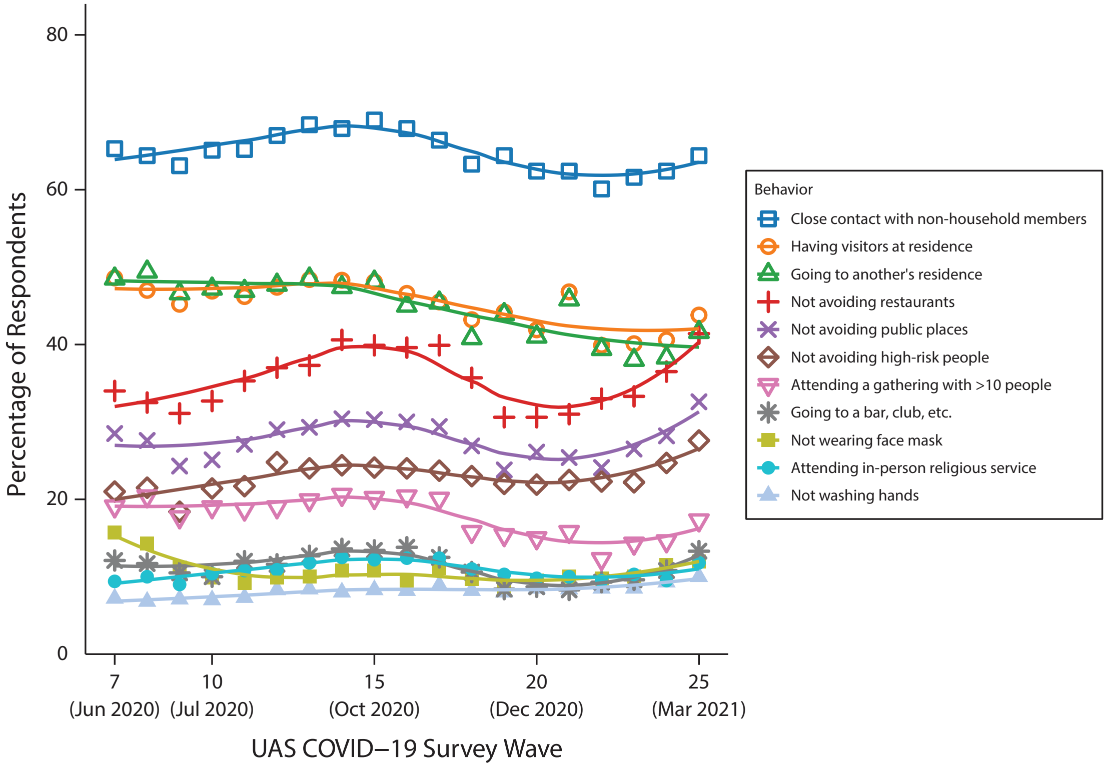

FIGURE 1— Percentage of Sample Respondents Engaging in Risk Behaviors at Each Understanding America Study (UAS) COVID-19 Survey Wave in the Study Period: United States, June 10, 2020–April 26, 2021

Note. We calculated percentages using weights provided by the UAS. The points represent the percentage of respondents engaging in the behavior at each wave, and the lines represent smoothed fits of these discrete estimates.

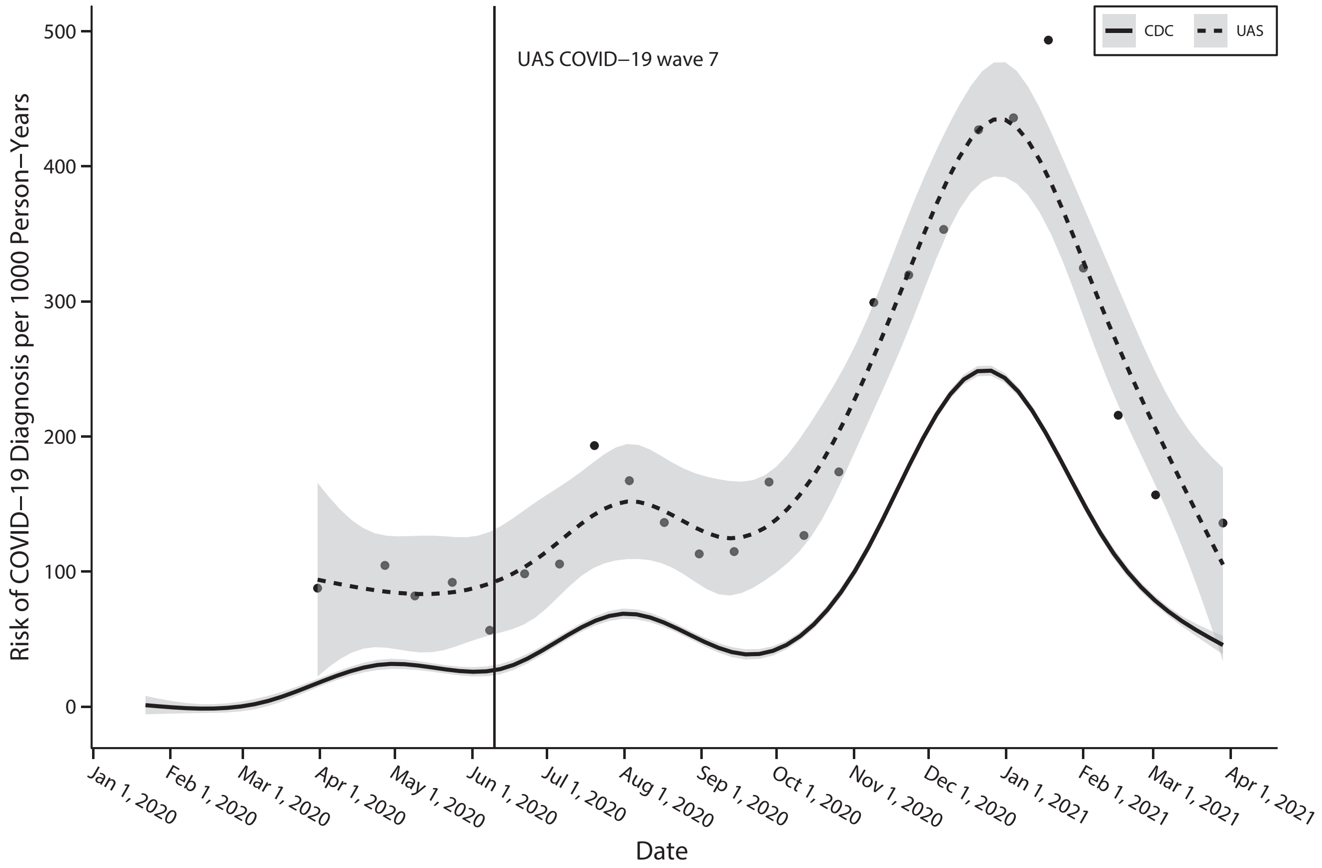

FIGURE 2— **Estimated Risk of COVID-19 Diagnosis in the Understanding America Study (UAS) COVID-19 Survey Compared With CDC Case Data: United States, January 2020–April 2021**

Note. CDC = Centers for Disease Control and Prevention. The dots represent the risk of incident COVID-19 diagnosis following each UAS wave, calculated as the number of incident diagnoses divided by the total number of person-years of exposure. The dotted line presents a smoothed fit of these discrete estimates. The vertical line indicates the beginning of wave 7, which was the first wave in our study period. The solid line represents a smoothed fit of the 7-day COVID-19 case rate reported by the CDC COVID Data Tracker. The UAS data included both positive test results and diagnoses by health care providers and were limited to adults 18 years and older. The CDC case data contained individuals of all ages.

always easily available for the general population and because individuals with mild cases may have forgone testing. Using both of these case definitions, we still found associations on the same order of magnitude as our main results (Tables D–E [available as a supplement to the online version of this article at http://www.ajph.org]). Besides the count of high-risk behaviors, we created a cumulative behavioral risk index (ranging from zero to 5 or more) to assess whether there is a dose–response or threshold effect. We found that the risk of COVID-19 appeared to increase with additional risky behaviors, especially for those who engaged in 4 or 5 or more risky behaviors compared to those who engaged in none (Table F [available as a supplement to the online version of this article at http://www.ajph.org]).

DISCUSSION

For much of the COVID-19 pandemic, nonpharmaceutical interventions, including behavioral modifications, were the only defense against COVID-19. Although vaccines are now widely available in the United States, the surge in infections fueled by the Delta variant underscores that behavioral modifications continue to be important for reducing the spread of COVID-19.[4] Although there have been numerous studies examining adherence to these behavioral guidelines,[30–32] there has been scant evidence to suggest that individuals who did not adhere to these guidelines actually faced a higher risk of COVID-19. In this study, we examined the association between behaviors considered high risk for COVID-19 and diagnosis of

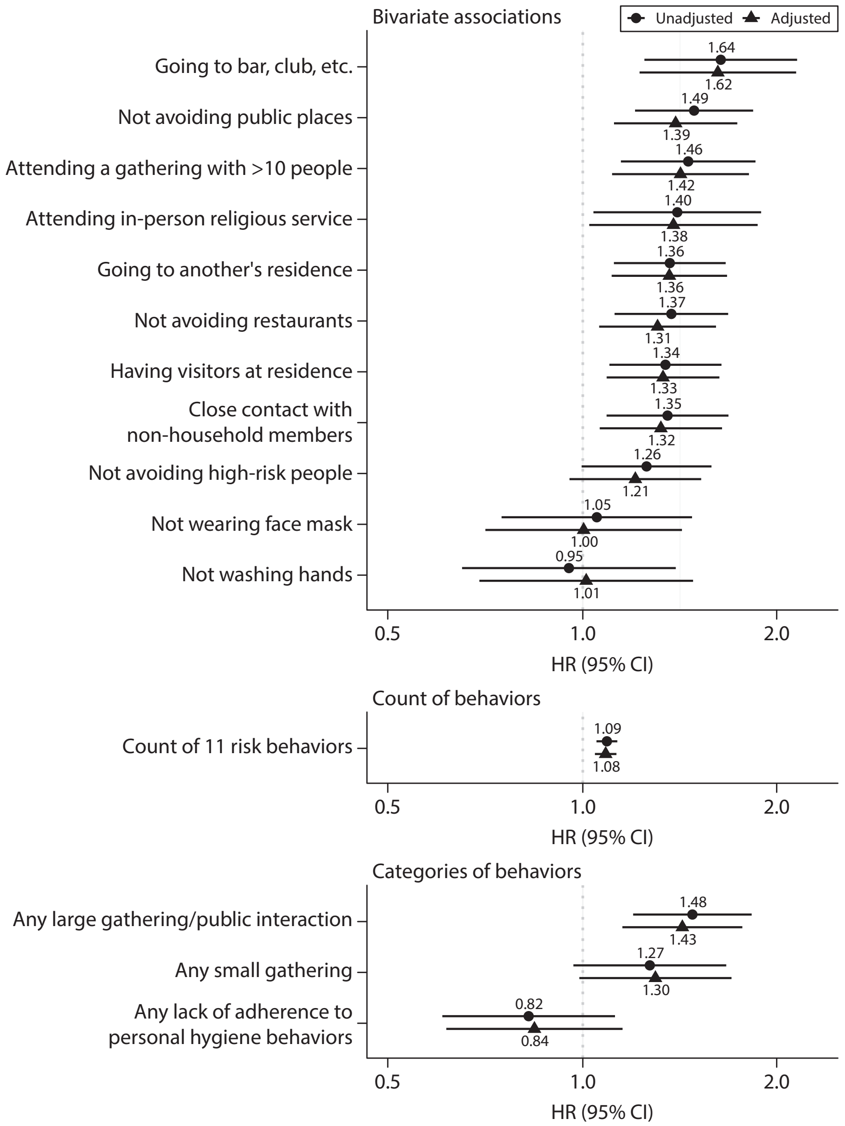

FIGURE 3— **Association Between Adherence to Personal Mitigation Behaviors and Risk of COVID-19 Diagnosis: Understanding America Study, United States, June 10, 2020–April 26, 2021**

Note. CI = confidence interval; HR = hazard ratio. Results from Cox proportional hazards models of 748 COVID-19 diagnoses over 4769 person-years of exposure. Unadjusted models included the behavior alone. Adjusted models additionally included sex, age category, race/ethnicity, educational attainment, employment status, living arrangement, and the natural logarithm of the state-level 7-day COVID-19 case rate.

COVID-19 using a nationally representative longitudinal data source.

We found that individuals who recently engaged in widely discouraged social activities, including going to a bar or club, attending in-person religious services, attending a gathering with more than 10 people, having visitors at one's residence, and having close contact with non–household members, had a significantly higher risk of being diagnosed with COVID-19 than did those who did not engage in these activities. Likewise, we found that individuals who did not report taking the precautions of avoiding public places or avoiding eating at restaurants had a significantly higher risk of a subsequent COVID-19 diagnosis. These findings generally persisted after controlling for a set of sociodemographic characteristics and were consistent with previous research at the population level that found that behaviors related to social distancing were associated with reduced COVID-19 infection.[6,8,9,11–15]

We also examined the number of high-risk behaviors, finding that each additional risk behavior was associated with an 8% to 9% higher risk of COVID-19, suggesting that individuals who engaged in multiple risk behaviors were infected more frequently than were those who engaged in fewer risk behaviors. Last, we found that individuals who engaged in at least 1 behavior related to large gatherings or public interactions had more than a 40% increased risk of contracting COVID-19 compared to those who did not engage in any of these behaviors. Even after controlling for engagement in large gatherings, those who engaged in at least 1 behavior related to small gatherings had an approximately 30% greater risk of COVID-19, a finding that was marginally significant. Although large gatherings appeared to be associated with a greater risk of COVID-19, our findings suggest that small gatherings are also important risk factors for COVID-19, consistent with previous research suggesting that small birthday gatherings were associated with household COVID-19 infections.[22]

We did not find the COVID-19–related personal hygiene behaviors of hand washing and mask wearing to be significantly related to COVID-19 diagnosis in this study. The UAS questionnaire simply asked whether one wore a face covering in the past week, without requiring respondents to specify frequency. Previous research indicates that this type of question wording, along with social desirability bias, may have led respondents to overreport these personal hygiene behaviors.[33] Those who reported not wearing a mask in the previous week were likely a heterogeneous group, including those who avoided interactions with others entirely and thus did not need to wear a mask and those who went out but chose not to wear a mask. Moreover, the question about wearing a face covering did not ask about the type or fit of the mask worn, both of which can influence the degree of protection conferred by the mask.[34] As a result of these data limitations and previous evidence documenting the effectiveness of masks,[5–7,11,34] we do not make claims about the effectiveness of masks and handwashing based on our null findings.

Strengths and Limitations

Strengths of this study include a nationally representative, individual-level data source with more than 10 months of follow-up. Because adherence to risk-mitigation behaviors varied over the course of the pandemic,[30–32] our study also benefited from information on numerous risk behaviors updated at regular intervals.

Despite these strengths, our study contained several limitations. First, although the UAS was designed to be nationally representative, individuals may be reluctant to participate in surveys they perceive as asking about sensitive topics, and it is possible that these individuals differed in terms of their exposure to COVID-19. Second, classification of COVID-19 diagnosis is imperfect. Respondents who had severe cases of COVID-19, were hospitalized, or died may have missed survey waves or dropped out of the survey entirely, leading us to misclassify their diagnosis date or incorrectly classify them as censored because of loss to follow-up. As with all studies of COVID-19 infection, we likely undercounted mild and asymptomatic infections because infection severity influences whether individuals get tested or seek medical care for COVID-19.[35] Third, the questions about personal behaviors do not capture all relevant aspects of risk and omit important details. For example, the question about avoiding restaurants does not distinguish between outdoor and indoor dining, and the question about close contact refers only to distance but not duration. Fourth, we are unable to establish a causal relationship between these risk factors and COVID-19 infection. It is not possible with our data and study design to determine exactly how an individual contracted COVID-19.

Public Health Implications

Our findings demonstrate that even in the presence of structural factors that influence the risk of infection, such as one's work or living situation, personal mitigation behaviors related to social distancing can influence risk of COVID-19. Although our study ended at a time when vaccines against COVID-19 were widely available for US adults, many areas had low vaccination rates, and evidence suggests that even vaccinated individuals can spread the highly transmissible Delta variant of SARS-CoV-2.[4] In this context, public health messaging should keep emphasizing the importance of these personal risk-mitigation behaviors, especially for unvaccinated individuals or in places where vaccination rates are low. These findings are also important to inform guidelines during future surges of COVID-19 or future outbreaks of viruses with similar transmission dynamics. AJPH

ABOUT THE AUTHORS

All of the authors are with the Leonard Davis School of Gerontology, University of Southern California, Los Angeles.

CORRESPONDENCE

Correspondence should be sent to Theresa Andrasfay, 3715 McClintock Ave, Los Angeles, CA 90089 (e-mail: andrasfa@usc.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

T. Andrasfay performed statistical analyses. T. Andrasfay, Q. Wu, and H. Lee wrote the first draft of the article. All authors conceptualized the study, interpreted the data, and revised the article.

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Note. The content of this article is solely the responsibility of the authors and does not necessarily represent the official views of the University of Southern California or the UAS.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

The UAS was approved by the University of Southern California institutional review board, and electronic informed consent was obtained from all participants.

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Unbalanced Authorship Cannot Produce Balanced Consideration of E-Cigarettes

Wasim Maziak, MD, PhD

ABOUT THE AUTHOR

The author is with the Robert Stempel College of Public Health and Social Work, Florida International University, Miami.

I read with interest the analysis piece by Balfour et al., recently published in *AJPH*.[1] In this piece, the authors correctly invited a balanced consideration of e-cigarettes among their opponents and proponents. Yet in the introduction, they declared that "[m]any, including this article's authors, believe that vaping can benefit public health, given substantial evidence supporting the potential of vaping to reduce smoking's toll."[1(p1662)] This statement basically places all of the authors in the "proponent group."

Although evidence is always the guide, balanced authorship can ensure a fair selection and interpretation of evidence, which I believe eluded this piece. An example of this unbalanced analysis of the evidence can be found in the authors' discussion of the "gateway" potential of e-cigarettes, that is, e-cigarette use among adolescents leading to later cigarette smoking. Here the authors presented and discussed several studies for and against the gateway effect among youths. Yet, only studies suggesting a gateway effect were subjected to scrutiny by the authors in terms of their limitations, despite the fact that they were for the most part based on stronger longitudinal designs than the studies presented to refute the gateway effect.[1] They also ignored studies that addressed their critiques of the gateway effect—by having a longitudinal design, adjusting for other tobacco and substance use, and examining regular cigarette smoking rather than experimentation—and still revealed the same association (see, e.g., Osibogun et al.[2]).

Furthermore, the authors presented the "gateway" and "common liability" as alternative explanations to the association between e-cigarette use and later cigarette smoking, when in reality they are likely to be complementary.[3,4] As Eric and Denise Kandel put it, "Common factors will explain the use of drugs in general, and specific factors will explain why young people use specific drugs and do so in a particular sequence."[4(p942)] Regardless of the strength and interpretation of evidence for and against the gateway effect, the fact that studies challenging the effect were given a free pass relative to the close scrutiny of the gateway studies is telling. Finally, the authors' dichotomy of adult smokers versus youth nonsmokers, whose interests need to be balanced, ignores the fact that adolescents are a vulnerable population—without much legal and political voice—who have nevertheless been thrown into the midst of this "social experiment of vaping" without their knowledge or consent.

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CORRESPONDENCE

Correspondence should be sent to Wasim Maziak, MD, PhD, Robert Stempel College of Public Health and Social Work, Florida International University, 11200 SW 8th St, Miami, FL 33199 (e-mail: wmaziak@fiu.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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Balfour et al. Respond

David J. K. Balfour, DSc, Neal L. Benowitz, MD, Suzanne M. Colby, PhD, Dorothy K. Hatsukami, PhD, Harry A. Lando, PhD, Scott J. Leischow, PhD, Caryn Lerman, PhD, Robin J. Mermelstein, PhD, Raymond Niaura, PhD, Kenneth A. Perkins, PhD, Ovide F. Pomerleau, PhD, Nancy A. Rigotti, MD, Gary E. Swan, PhD, Kenneth E. Warner, PhD, and Robert West, PhD

ABOUT THE AUTHORS

David J. K. Balfour is retired from the Division of Systems Medicine, School of Medicine, University of Dundee, Dundee, UK. Neal L. Benowitz is with the Department of Medicine, School of Medicine, University of California, San Francisco. Suzanne M. Colby is with the Department of Psychiatry and Human Behavior, Alpert Medical School, Brown University, Providence, RI. Dorothy K. Hatsukami is with the Department of Psychiatry and Behavioral Sciences, Medical School, University of Minnesota, Minneapolis. Harry A. Lando is with the Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, Minneapolis. Scott J. Leischow is with the College of Health Solutions, Arizona State University, Phoenix. Caryn Lerman is with the Norris Comprehensive Cancer Center, Keck School of Medicine, University of Southern California, Los Angeles. Robin J. Mermelstein is with the Department of Psychology, University of Illinois–Chicago. Raymond Niaura is with the Department of Epidemiology, School of Global Public Health, New York University, New York, NY. Kenneth A. Perkins is with the Department of Psychiatry, School of Medicine, University of Pittsburgh, Pittsburgh, PA. Ovide F. Pomerleau is with the Department of Psychiatry, Medical School, University of Michigan, Ann Arbor. Nancy A. Rigotti is with the Department of Medicine, Massachusetts General Hospital, Harvard Medical School, Boston, MA. Gary E. Swan is with the Stanford Prevention Research Center, Department of Medicine, Stanford University School of Medicine, Palo Alto, CA. Kenneth E. Warner is with the Department of Health Management and Policy, School of Public Health, University of Michigan, Ann Arbor. Robert West is with the Department of Behavioural Science and Health, University College London, London, UK.

Wasim Maziak takes issue with only one of our article's many topics: youth vaping as a gateway to cigarette smoking. He is correct that we subject the prospective studies to greater scrutiny than we do the articles challenging them. The prospective studies constitute the gateway theory evidence base, yet they have been subjected to relatively little critical examination. Covering as much territory as does our article, we did not have space to analyze every cited article. But as with each subject we consider, we provide ample references from which readers can draw their own conclusions.

Maziak asserts that the authors "also ignored studies that addressed their critiques of the gateway effect—by having a longitudinal design, adjusting for other tobacco and substance use, and examining regular cigarette smoking rather than experimentation—and still revealed the same association." He cites one study[1] of which we were unaware. We had found only three studies[2–4] that included other tobacco use. Only one of these[4] also included marijuana, although solely in a sensitivity analysis in supplementary material. In the article's text referring to this sensitivity analysis, the authors wrote that vaping-smoking "[a]ssociations decreased in magnitude with adjustment for marijuana use."[4(p184)] They failed to mention that the association with past 30-day smoking became nonsignificant. Similarly, as noted in our article, two articles by Wills et al.,[5,6] using the identical data set, demonstrate that the inclusion of marijuana and three other variables[5] eliminates the statistically significant relationship between vaping and subsequent smoking reported in the article that omitted these variables.[6]

Maziak considers the authorship of our article "unbalanced" because we believe there is substantial evidence that vaping can help some adult smokers to quit smoking, and that this can improve public health. We provide substantial documentation. Having devoted our careers to the welfare of both youth and adult smokers, we call for a more balanced consideration of the impacts of vaping because both are important and the current fervent emphasis on youth may come at a potentially significant cost to adult smokers. The powerful influence on the media and legislators of well-funded organizations like the Campaign for Tobacco Free Kids[7] and the Truth Initiative,[8] singularly focused on youth vaping, belies Maziak's claim that "adolescents are a vulnerable population without a legal and political voice." One could argue that the marginalized populations comprising adult smokers are the vulnerable groups lacking a political voice.

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ABOUT THE AUTHORS

David J. K. Balfour is retired from the Division of Systems Medicine, School of Medicine, University of Dundee, Dundee, UK. Neal L. Benowitz is with the Department of Medicine, School of Medicine, University of California, San Francisco. Suzanne M. Colby is with the Department of Psychiatry and Human Behavior, Alpert Medical School, Brown University, Providence, RI. Dorothy K. Hatsukami is with the Department of Psychiatry and Behavioral Sciences, Medical School, University of Minnesota, Minneapolis. Harry A. Lando is with the Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, Minneapolis. Scott J. Leischow is with the College of Health Solutions, Arizona State University, Phoenix. Caryn Lerman is with the Norris Comprehensive Cancer Center, Keck School of Medicine, University of Southern California, Los Angeles. Robin J. Mermelstein is with the Department of Psychology, University of Illinois–Chicago. Raymond Niaura is with the Department of Epidemiology, School of Global Public Health, New York University, New York, NY. Kenneth A. Perkins is with the Department of Psychiatry, School of Medicine, University of Pittsburgh, Pittsburgh, PA. Ovide F. Pomerleau is with the Department of Psychiatry, Medical School, University of Michigan, Ann Arbor. Nancy A. Rigotti is with the Department of Medicine, Massachusetts General Hospital, Harvard Medical School, Boston, MA. Gary E. Swan is with the Stanford Prevention Research Center, Department of Medicine, Stanford University School of Medicine, Palo Alto, CA. Kenneth E. Warner is with the Department of Health Management and Policy, School of Public Health, University of Michigan, Ann Arbor. Robert West is with the Department of Behavioural Science and Health, University College London, London, UK.

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CORRESPONDENCE

Correspondence should be sent to Kenneth E. Warner, Department of Health Management and Policy, School of Public Health, University of Michigan, 1415 Washington Heights, Ann Arbor, MI 48109 (e-mail: kwarner@umich.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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K. E. Warner drafted and revised this letter following its review by all other authors; several suggested changes. All other authors reviewed drafts and approved the final letter.

CONFLICTS OF INTEREST

N. L. Benowitz is a consultant to Pfizer and Achieve Life Sciences, companies that market or are developing smoking cessation medications, and has been an expert witness in litigation against tobacco companies. S. J. Leischow is conducting a clinical trial supported by Achieve Life Sciences, which is developing a nonnicotine medication for smoking cessation, and has consulted with them. He also consulted more than one year ago for GSK, which is working to bring a new nicotine replacement product to market, and he receives medication for a National Institutes of Health–funded smoking-cessation study from Pfizer. N. A. Rigotti receives royalties from UpToDate Inc for writing about smoking cessation and e-cigarettes and is a consultant for Achieve Life Sciences for an investigational smoking-cessation medication. R. West has undertaken research and consultancy for Pfizer and GSK, companies that manufacture smoking-cessation medications.

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E-Cigarettes as Consumer Products

Stanton A. Glantz, PhD

ABOUT THE AUTHOR

Stanton Glantz is a retired University of California San Francisco (UCSF) professor of medicine and founding director of the UCSF Center for Tobacco Control Research and Education.

Balfour et al.[1] argued for balancing the risks and benefits of e-cigarettes, based on the value of e-cigarettes as cigarette smoking–cessation aids for adult smokers. In particular, they cited our meta-analysis of e-cigarettes and smoking cessation[2] to support their statement, "Other researchers have found regular and frequent e-cigarette use to be associated with increased smoking cessation, while infrequent use was not."[1(p1663)]

Like the discussion by Balfour et al. of the health effects of e-cigarettes, including the effects of nicotine on children,[3] this statement is a highly selective reading of our article.

Specifically, although it is correct that we found that daily e-cigarette use was associated with significant increases in cigarette cessation (odds ratio [OR] = 1.529; 95% confidence interval [CI] = 1.158, 2.019), we also found that nondaily use was associated with significantly less quitting (OR = 0.514; 95% CI = 0.402, 0.656). Most importantly, among all users, there was no significant association between e-cigarette consumer product use and quitting (OR = 0.947; 95% CI = 0.772, 1.160), the key conclusion in our article.

Balfour et al. ignored this primary conclusion and instead focused on criticizing our earlier meta-analysis,[4] which was superseded by the new article[2] that was based on more than twice as many studies and was specifically designed to address the limitations of the earlier work.

We did find that the randomized controlled trials of free e-cigarettes provided in smoking-cessation trials (often combined with counseling) were associated with increased cessation.[2] As Balfour et al.,[1] Samet and Barrington-Trimis,[3] and we[2] recognized, randomized controlled trials are relevant for assessing medicines, not consumer products. Indeed, Balfour et al. recognized, "Noteworthy is the lack of trials by e-cigarette manufacturers in pursuit of regulatory agency approval to use e-cigarettes for smoking cessation, likely reflecting the profitability of selling e-cigarettes as consumer products, rather than medicinal devices."[1(p1663)] These randomized controlled trials are not, however, relevant to the US Food and Drug Administration Center for Tobacco Products' decision of whether to authorize sale of e-cigarettes as consumer products in the United States.

Balfour et al. ignored our primary conclusions: "As consumer products, in observational studies, e-cigarettes were not associated with increased smoking cessation in the adult population" and, so, "E-cigarettes should not be approved as consumer products."[2(p.e1)]

CORRESPONDENCE

Correspondence should be sent to Stanton A. Glantz, PhD, 1474 24th Ave, San Francisco, CA 94122 (e-mail: stanton.glantz@sonic.net). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONFLICTS OF INTEREST

The author reports no conflicts of interest.

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Balfour et al. Respond

David J. K. Balfour, DSc, Neal L. Benowitz, MD, Suzanne M. Colby, PhD, Dorothy K. Hatsukami, PhD, Harry A. Lando, PhD, Scott J. Leischow, PhD, Caryn Lerman, PhD, Robin J. Mermelstein, PhD, Raymond Niaura, PhD, Kenneth A. Perkins, PhD, Ovide F. Pomerleau, PhD, Nancy A. Rigotti, MD, Gary E. Swan, PhD, Kenneth E. Warner, PhD, and Robert West, PhD

ABOUT THE AUTHORS

David J. K. Balfour is retired from the Division of Systems Medicine, School of Medicine, University of Dundee, Dundee, UK. Neal L. Benowitz is with the Department of Medicine, School of Medicine, University of California, San Francisco. Suzanne M. Colby is with the Department of Psychiatry and Human Behavior, Alpert Medical School, Brown University, Providence, RI. Dorothy K. Hatsukami is with the Department of Psychiatry and Behavioral Sciences, Medical School, University of Minnesota, Minneapolis. Harry A. Lando is with the Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, Minneapolis. Scott J. Leischow is with the College of Health Solutions, Arizona State University, Phoenix. Caryn Lerman is with the Norris Comprehensive Cancer Center, Keck School of Medicine, University of Southern California, Los Angeles. Robin J. Mermelstein is with the Department of Psychology, University of Illinois–Chicago. Raymond Niaura is with the Department of Epidemiology, School of Global Public Health, New York University, New York, NY. Kenneth A. Perkins is with the Department of Psychiatry, School of Medicine, University of Pittsburgh, Pittsburgh, PA. Ovide F. Pomerleau is with the Department of Psychiatry, Medical School, University of Michigan, Ann Arbor. Nancy A. Rigotti is with the Department of Medicine, Massachusetts General Hospital, Harvard Medical School, Boston, MA. Gary E. Swan is with the Stanford Prevention Research Center, Department of Medicine, Stanford University School of Medicine, Palo Alto, CA. Kenneth E. Warner is with the Department of Health Management and Policy, School of Public Health, University of Michigan, Ann Arbor. Robert West is with the Department of Behavioural Science and Health, University College London, London, UK.

Stanton Glantz writes that “the key conclusion” in his and his colleagues’ meta-analysis was that “among all [e-cigarette] users, there was no significant association between e-cigarette consumer product use and quitting [smoking].”[1] This finding derives from the authors combining daily e-cigarette users, who show significantly increased smoking cessation rates, with nondaily users, who have significantly lower quit rates. We consider it illogical to merge the two. In our article,[2] we say that the difference in quit rates could reflect self-selection: daily e-cigarette users may be more motivated to quit smoking, whereas some infrequent vapers may use e-cigarettes as a temporary nicotine source where smoking is prohibited. The point is that people who want to quit smoking and use e-cigarettes frequently exhibit a statistically significantly increased odds of quitting, just as with daily versus infrequent adherence to nicotine replacement therapy.[3] We suggest that regular vaping may help a subset of smokers—not all smokers—to quit. We see e-cigarettes, properly regulated, as representing a potentially important addition to the armamentarium of smoking cessation treatments and policies.

On the basis of their key conclusion, Glantz and his colleagues drew a second “principal conclusion,” namely, that “E-cigarettes should not be approved as consumer products.”[1(p.e1)] We disagree. First, as noted, the key conclusion on which this second conclusion rests inappropriately merges the experiences of daily e-cigarette users with those of nondaily users. Second, approval of e-cigarettes as consumer products should derive from review of all the evidence. In our article, we enumerate four distinct types of evidence that, combined, resulted in our conclusion that e-cigarettes likely increase smoking cessation. We consider the evidence strong, if not definitive (as stated in the article). One of those types of evidence is randomized clinical trials, which, Glantz acknowledges, find e-cigarettes more effective for quitting smoking than Food and Drug Administration–approved nicotine replacement therapy products. However, Glantz considers RCTs not relevant to the use of e-cigarettes as consumer products. We disagree. Although not sufficient on their own, randomized clinical trials can provide valuable evidence regarding product safety, use patterns, and the impact on other tobacco product use, among other things.

Unlike Glantz, many of us have never taken a position on e-cigarettes. Indeed, we have diverse views on the range of e-cigarette issues. Our article reflects our collective review of the evidence and many conversations about its interpretation. AJPH

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CORRESPONDENCE

Correspondence should be sent to Kenneth E. Warner, Department of Health Management and Policy, School of Public Health, University of Michigan, 1415 Washington Heights, Ann Arbor, MI 48109 (e-mail: kwarner@umich.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

K. E. Warner wrote the original draft response to S. Glantz's letter. All other authors reviewed the draft and several suggested revisions that were incorporated in the submitted version of the letter.

CONFLICTS OF INTEREST

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