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The Nexus of Climate Change, COVID-19, and Environmental Justice on Children's Health

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Introduction

In the last decade, climate change has taken center stage as the greatest public health threat.[1] Extreme weather events and declines in both air and water quality have resulted in escalating threats of mortality, morbidity, displacement, food insecurity, and mental health problems.[2,3] In 2020, the COVID-19 pandemic eclipsed concerns about climate change as a public health threat. Health professionals who follow the influence of climate change and the social determinants of health on children's health see the data regarding COVID-19, and although alarming, this was not a surprise. COVID-19 is a threat multiplier to children's health. For children who experience the adverse consequences of climate change, COVID-19 amplified their vulnerabilities and compounded the health impacts.

All children are at risk from the effects of climate change and COVID-19, but children in marginalized poor communities and communities of color have faced greater negative health impacts from both public health crises. Understanding the amplification of simultaneous public health threats and addressing the underlying causes can support the health of children, especially the most vulnerable. In this article, we will highlight the impact of air quality and mental health on children in marginalized communities experiencing poverty, the effects of systemic racism, and environmental justice as it relates to the combined public health threats of climate change and COVID-19 in the United States. In addition, we will offer solutions for health care providers and researchers to act in reducing exposures and elevating the social determinants to improve children's health. Actions to preserve and enhance opportunities for experiences in nature, particularly in marginalized communities, are presented.

Climate Change and COVID-19: Risk to Children's Health

Per unit of body mass, children drink more, eat more, and breathe more than adults. They also have rapid metabolisms and are at various developmental stages of vulnerability.[4] Therefore, children are particularly vulnerable to the health effects of environmental exposures, whether the exposures are impacts of climate change or the environmental risks of a new and emerging infectious disease (EID), such as COVID-19. Additionally, young children depend on adults to protect them from environmental exposures.[4] For children belonging to marginalized communities who need environmental justice protections, these hazards are intensified by unhealthy levels of air pollution, chronic stress, and associated mental health issues.[5]

In the US, there is a relationship between race, ethnicity, and poverty, which are related to the historical impacts of redlining[6] and discriminatory practices of employment and wages.[7] The American link between poverty and race from the history of structural racism has negatively impacted the health and futures of children of color. The COVID-19 pandemic highlighted the social and cultural inequalities that have led to health disparities of minority US populations.[8] The confluence of the social determinants of health on the health of children is manifested in the dueling climate and COVID-19 public health crises, making this also an issue of justice.

Low-income populations and communities of color that are already overburdened with environmental exposures lack the capacity for adaptation and resilience to address the health impacts of climate change.[9] Marginalized populations overburdened by pollution in their communities are at greater risk to the health effects of catastrophic weather events fueled by climate change.[2] For example, Hurricane Harvey significantly impacted socioeconomically disadvantaged communities, which were predominantly Black and Latino/a, in the Houston metro area, with an increase in both the physical and mental health impacts associated with the flooding[11] Populations exposed to floodwaters were at increased risk of upper respiratory allergic symptoms and higher stress when compared with unexposed populations.[10]

This was also observed during the COVID-19 pandemic, as the most vulnerable to COVID-19 infection and hospitalizations were Black and Latino/a people who are of lower socioeconomic status.[11] Greater risk of succumbing to the virus has been related to chronic diseases such as hypertension, heart disease, and diabetes that are linked to living conditions and social determinants of health. Native American children living on tribal land and reservations are at increased risk of COVID-19 exposure and having a family member with severe COVID-19. The reasons for this risk are that remote communities rely on collective activities for food, labor, and inter-community travel, making social distancing restrictions challenging.[12] Just as extreme weather events may limit travel, the limitations of travel during COVID-19 for remote communities increased the gap in disease management of existing conditions, such as asthma, and emergency responses.[8] For Asian-American children, there have been reports of teasing and harassment for erroneously being accused of spreading the “China virus.”[13] Indigenous and immigrant families are also marginalized by language barriers, cultural practices, lack of understanding of the US health system and emergency communications, and discrimination by providers.[14]

Air Quality

Air quality in low-income communities also impacts children's health. The warming conditions and rising atmospheric carbon dioxide have led to more pollen production and a longer pollen season.[15] Increased wildfires, smoke, and dust also add to particulates in the air. Additionally, the warmer conditions from climate change contribute to increases in ground-level ozone, which can be an asthma trigger. Climate change-related air pollution contributes to asthma exacerbations and other respiratory illnesses for children, especially those in overburdened communities.[4,16] According to the Centers of Disease Control and Prevention, young children (between 0-4 years old) and Non-Hispanic Black children are the most frequent emergency and urgent care pediatric asthma patients.[17]

Children living in marginalized urban communities were more likely to have increased risks of COVID-19 exposure due to living in crowded housing and had greater exposure to poor air quality that increases one's risk for acquiring and becoming ill from COVID-19.[18,19] This was especially problematic in urban areas with high $PM_{2.5}$, diesel particulates, proximity to disposal facilities, and nitrogen dioxide pollution.[20,21,22,23] These pollutants also contribute to asthma exacerbations,[24] although it remains to be seen if there is a relationship between pediatric asthma and severity of COVID-19.[25]

Mental Health

The devastating aftermath of extreme weather events is especially traumatic for children. The more frequent occurrence of climate change-fueled natural disasters has increased the incidence of post-traumatic stress disorder (PTSD) and major depressive disorder (MDD) due to weather events.[26] Stressors within families from climate disasters or COVID-19 can initiate or exacerbate violence and domestic abuse. Experiencing such trauma and stressors in early life can lead to adverse childhood experiences (ACEs), which have been associated with lifelong health problems by increasing the risk of chronic diseases, mental illness, and lower life expectancy.[27] Additionally, the traumatic consequences of climate change may leave permanent effects upon a child's mental health that may continue into adulthood, including the diminished ability to regulate emotions, aggressive behaviors, deficiencies in cognition and communication skills, and weak academic performance.[10,11]

The long-term effects of COVID-19 on children's mental health need further research. What is known is that pre-existing mental health issues were amplified for children and their families during the pandemic; this is especially true for parents who were receiving financial assistance before COVID-19 and those with histories of anxiety and depression.[28] Furthermore, children who already experienced maltreatment and ACEs prior to COVID-19 were found to experience greater anxiety related to their perceived threat of the virus.[27] The risk of mental health problems was also noted to be increased for children living in crowded housing, for families with low educational attainment, and for children in immigrant families.[29]

Family income and parents' employment also influenced children's anxiety and mental health. Low-income parents were more likely to be "essential workers" necessitating work outside the home during COVID-19, including the "lockdown." This led to greater separation from the parent and stress on children as adult family members had increased rates of hospitalization or COVID-19 mortality.[30] Loss of work, food and income insecurity, and family members' illnesses have been associated with poor mental health for the parents and children in households of color.[31,32] Furthermore, when children needed to be quarantined due to a COVID-19 exposure, parents reported regressive behavior in their children.[33] One strategy to reduce the risk of mental health problems was to be outdoors. When families were able to be outdoors and in nature during COVID-19, fewer mental health symptoms of children were reported.[34] In addition, evidence shows that trees and nature play an important role in improving air quality, cooling communities during heat waves, and enhancing psychological well-being.[35]

School closures that occurred during the pandemic or climate change-related disasters create social isolation and limited access to screening and care. Children at home all day are at greater risk of exposure to substance abuse by their caregivers, domestic violence, child abuse, gambling, and more time in overcrowded conditions.[36,37] For many children and adolescents, school is the first place where problems may be observed by an adult and the first place that a child may safely seek help.[36] Larsen and colleagues noted that the strongest predictor of a child's response to COVID-19 was their perception of the family's stress and stability.[38] Consequently, for a child in a stressful or unstable home environment, homeschooling during COVID-19 removed an emotional safety net and placed the child in a more stressful situation for the whole

day. The social isolation of COVID-19 was an additional issue for adolescent development, as peers become increasingly important for adolescence and they move toward greater independence from their parents.[39] Furthermore, social isolation places children with existing mental health problems at greater risk of panic, despair, and anxiety.[40] Once COVID-19 restrictions have been lifted, there is concern about children transitioning back to school, especially those who have educational and health risks.[41] Disruptions in services and school support for children have also been observed in climate change disasters such as Hurricane Katrina in 2005.[42]

National Strategies for Advancing Children's Health in Marginalized Communities

Protecting children's health from the effects of EIDs and climate change will require the development of national strategies that focus on addressing cumulative health effects experienced by overburdened communities.[8,20,43] The nexus of climate change and COVID-19 with the influence of the social determinants of health on environmental justice is depicted in Figure 1. The programs described in this section can address climate change, COVID-19, environmental justice, and future health risks to children.

The Biden administration has taken important steps to re-enact policies and legislation that will move the US forward in reducing greenhouse gases (eg, mitigation measures) and improving air quality, as well as addressing social determinants of health such as housing (eg, prevention strategies).[44] These measures provide an important launching point to build financial capacity and environmental sustainability in at-risk communities, but more must be done to address the complex issues arising from the intersection of COVID-19 and climate change.

Growing concerns have been raised regarding the mental health needs of children and families during the pandemic, compounded by the added psychological burdens from threats associated with climate change and the stressors of poverty.[45] While it is customary to focus on an individual's mental health, the complex intersection of stressors and risks with the lack of social protections dictates that society focuses on the broader policy issues that increase risks for mental illness in overburdened communities.[46] Governments must commit to a long-term, multifaceted approach that addresses social determinants of health including improvement in housing, schools, wages, transportation,

environmental protections, and public health measures that will protect at-risk communities and lift them from impoverished conditions.

As the nation recovers post-pandemic, accessible, affordable mental health services that address the unique needs of children should be readily available. These services should be established within a well-funded national system of mental health services that build resiliency, given the complex, intersecting concerns of the pandemic and climate change threats.[47,48]

Recognizing the Importance of Schools to Children's Well-being

Children spend a great deal of their time in learning settings (eg, schools, childcare). The pandemic has exposed the many benefits that are provided and lost during its existence, particularly for students living in poverty. Free lunch programs and mental health services are just two of the lost benefits. A robust national plan for schools is needed to ensure that all students are able to access these basic necessities during times of crisis, whether it be a pandemic or an extreme weather event.

The safety of the indoor environment as children return to these settings has come under scrutiny. Ineffective, outdated HVAC systems, unable to control the spread of disease, are housed in facilities that are in serious decline. Inferior indoor environments can lead to poor academic performance and poor health. There is a need to consider the important role that schools play in promoting positive physical and mental health and to support funding improvements in facilities nationally. While the Environmental Protection Agency has the existing authorizations and the programs to conduct this work, additional funding is required to operationalize these efforts, particularly in impoverished communities.

The Role of Nature on Health

There is a link between EIDs such as COVID-19, climate change, and the increasing human intrusion into the natural world, including the consumption of wildlife products.[49] Policies that focus on preventing detrimental encroachment into natural ecosystems could reduce the potential for future increases in zoonotic EIDs.[50]

Evidence also points to the mental health benefits of contact with nature, leading to lower levels of stress and acting as a buffer in distressing situations, particularly for children and adolescents. Researchers have found that after controlling for socioeconomic status, children with more "natural" areas in and near their homes experienced less psychological distress in response to stressful life events. Results highlight the critical role that outdoor time plays in strengthening children's

resilience to stressors such as the COVID-19 pandemic and underscore the need to facilitate outdoor opportunities during times of crisis.[51,34] Creating more green spaces (eg, parks) that are publicly available, while protecting natural spaces that are already established, can promote outdoor activity and lead to positive mental health impacts.

The benefit of trees in the removal and sequestration of carbon dioxide, while producing oxygen, underscores the importance of creating and maintaining urban forests to mitigate climate change with the added benefit of enhancing physical and mental health. Research to better understand how trees benefit urban ecosystems, particularly in blighted communities, can be used to develop national policies that can improve the environment and the nation's health.[52]

We know that climate change is disrupting how we interact with nature.[26] Preservation of our environment through governmental policies at the local, state, and national levels is critical to maintaining mental health – especially in communities overburdened by pollution and poverty. Providing opportunities for families to engage in outdoor activities in these natural spaces can be accomplished through a variety of environmental and community organizations, schools, and even health professionals (eg, https://parkrxamerica.org).

The Role of Health Professionals

Public health professionals and health providers can play a vital role in local and regional climate strategies by preparing their communities to effectively address the anticipated physical and mental health impacts of the COVID-19 pandemic and climate change. The Pediatric Environmental Health Specialty Unit (PEHSU) national network has successfully engaged communities to address reproductive and children's environmental health, including impacts from climate change and COVID-19 (www.pehsu.net). With part of its mission to address historical injustices and ongoing environmental racism, the PEHSU network has successfully engaged with overburdened communities by acting as a resource, facilitating opportunities to reduce environmental health risks, preserving the environment, and increasing knowledge about the benefits of spending time outdoors.

Conclusion

The true scale of the effects of COVID-19 compounded by climate change impacts will not be fully known and understood for years post-pandemic. As we begin to ascertain the successes and limitations of the

resiliency of communities who invested in bolstering public health and funding disaster recovery response, we have the unique opportunity to learn from past errors, adapt programs that have worked, and reconfigure equity-driven approaches to address climate change and future epidemics. Due to loss of habitat via climate change and human encroachment upon the habitat of wildlife, the likelihood of novel EIDs developing in these strained reservoirs increases.[49,53]

The complex realities of combating health impacts from COVID-19 (and future EIDs) intersecting with impacts from climate change, especially in marginalized communities, will require a multifaceted approach that focuses on equity. By keeping the lens of environmental justice in policy action, each community could have protection from infectious diseases and climate change threats. All could have an equitable voice in the decisions that will impact their health.[54]

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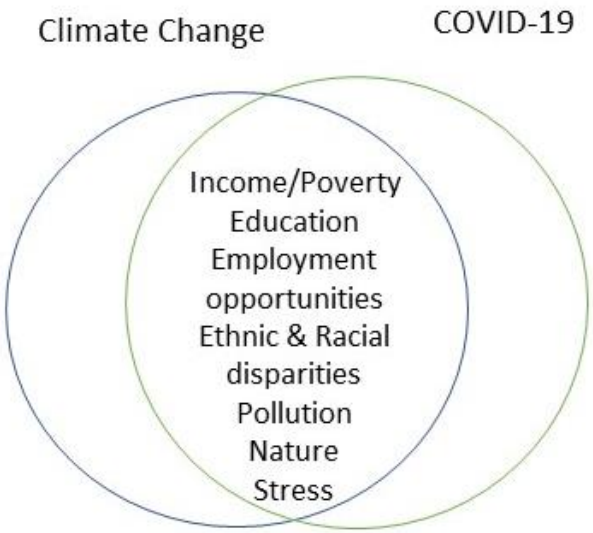

Figure: Social Determinants of Health influence on Environmental Injustice