Nos. 20-1530, 20-1531, 20-1778, and 20-1780

IN THE

Supreme Court of the United States

STATE OF WEST VIRGINIA, ET AL., *Petitioners*,

v.

U.S. ENVIRONMENTAL PROTECTION AGENCY, ET AL.,
Respondents.

On Writs of Certiorari to the United States Court of Appeals for the District of Columbia Circuit

BRIEF OF AMICI CURIAE AMERICAN THORACIC SOCIETY, AMERICAN MEDICAL ASSOCIATION, AMERICAN ACADEMY OF PEDIATRICS, AMERICAN COLLEGE OF PHYSICIANS, AND LEADERS OF PUBLIC HEALTH SCHOOLS, ET AL. IN SUPPORT OF RESPONDENTS

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INTEREST OF AMICI[1]

Amici are leading physician-member public health organizations, as well as deans, directors, and chairs of public health schools across the country. Organizational amici include the American Thoracic Society, American Medical Association, American Academy of Pediatrics, American College of Physicians, National Medical Association, The Endocrine Society, American Society of Hematology, Academic Pediatric Association, American Medical Women's Association, Society of General Internal Medicine, The American Academy of Allergy, Asthma & Immunology, American Association for Community Psychiatry, American Association of Respiratory Care, American College of Occupational and Environmental Medicine, Climate Psychiatry Alliance, American Academy of Otolaryngic Allergy, and the American Society of Cataract and Refractive Surgery. A complete list of the 42 individual amici and their institutional affiliations appears in Appendix A.

Amici are deeply concerned about the serious and widespread public health harms resulting from anthropogenic climate change, including illness and premature death, and escalating emergency room visits throughout the United States. This brief describes the public health necessity of regulating—and reducing—emissions of greenhouse gases such as

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[1] Pursuant to Rule 37.6, amici state that no counsel for a party authored this brief in whole or in part and that no person other than amici and their counsel made a monetary contribution to its preparation or submission. All parties filed a blanket consent to the filing of amicus briefs with the exception of the Power Company Respondents. Amici obtained consent from the Power Company Respondents on December 16, 2021.

carbon dioxide that fuel climate change (collectively, "climate pollutants"). The resolution of this case could have a profound impact on the ability of the Environmental Protection Agency ("EPA" or "the Agency") to set emissions standards for the largest industrial source of climate pollutants in the United States. Any ruling that reduces the ability of EPA to discharge its public health mission under the Clean Air Act would harm the public welfare. Amici's collective medical expertise and experience lead them to support the position of the respondents.

INTRODUCTION

June 2021 was the warmest month ever recorded on the United States mainland.[2] Temperatures soared across the Pacific Northwest, reaching 116°F in Portland.[3] As record-shattering temperatures seared Oregon and Washington, people flooded emergency rooms seeking care. On June 28th, the U.S. Department of Health and Human Services reported 1,038 emergency room visits for heat-related illness across the Pacific Northwest region; one year earlier on the same day, there were nine.[4] Hospital systems,

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[2] National Oceanic and Atmospheric Administration, *State of the Climate: Global Climate Report for June 2021*, National Centers for Environmental Information, https://www.ncdc.noaa.gov/sotc/global/202106 (last accessed January 12, 2022).

[3] Paul J. Schramm et al., *Heat-Related Emergency Department Visits During the Northwestern Heat Wave – United States, June 2021*, 70 Morbidity and Mortality Wkly. Rep. 1020, 1020 (2021) (noting that temperatures reached 42°F hotter than average June temperatures).

[4] *Id.*

already stressed by the COVID-19 pandemic, struggled to admit the surge of patients and medical equipment overheated.[5]

Higher temperatures and punishing heat waves that contribute to illness and injury are two prominent effects of climate change that harm public health. America's leading physician-member medical organizations and public health experts submit this brief to draw the Court's attention to the exigent health threats from climate change. Driven by fossil fuel emissions, climate pollutants harm public health across every segment of American society and in every state. The consequences of climate change impair pulmonary, cardiovascular, neurological, immunological, behavioral health, and other vital systems and functions.

The scale and gravity of these dangers demand regulatory action to reduce emissions of greenhouse gases, including carbon dioxide. Amici urge this Court not to reduce the EPA's ability to regulate carbon dioxide emissions from power plants to protect public welfare and mitigate future public health harms.

SUMMARY OF ARGUMENT

Human-generated greenhouse gas emissions, including carbon dioxide from fossil-fuel combustion, have changed weather patterns and other natural cycles across the world. If left unchecked, this trend will continue, with worsening and compounding public health consequences. In the United States,

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[5] Joanne Silberner, *Heat wave causes hundreds of deaths and hospitalizations in Pacific north west*, 374 BMJ 1696, 1696 (2021).

greenhouse gas-related changes to the weather include more frequent heat waves, higher average temperatures, more forest and urban fires, more air pollution, longer and intensified allergy seasons, more potent and frequent storms and flooding, and expansion in the range of disease-carrying insects. All of these changes will continue to have dangerous health consequences.

These consequences include rises in heat-related illnesses, air pollution-related respiratory and cardiovascular illnesses, injuries and deaths caused by severe fires and storms, the spread of vector-borne diseases like Zika and Dengue, and increases in asthma attack-triggering pollen and mold. The effects of greenhouse gas emissions are occurring in all fifty states, but the harms are not equally distributed. Climate pollutants' most grievous harms beset children and infants, pregnant women, people over 65, and communities of color and of low income.

Volumes of peer-reviewed science on such health effects reinforce the conclusion that climate pollutants warrant action from EPA. The Clean Air Act authorizes EPA to regulate greenhouse gases as air pollutants as defined under the Act, *Massachusetts v. EPA*, 549 U.S. 497, 528-532 (2007), and mandates their regulation because they endanger public health and welfare. 80 Fed. Reg. 64,510, 64,530-31 (Oct. 23, 2015). As this Court affirmed, "Congress delegated to EPA the decision whether and how to regulate carbon-dioxide emissions from powerplants." *American Electric Power Co. v. Connecticut*, 564 U.S. 410, 426 (2011).

The EPA's authority to regulate carbon dioxide emissions from power plants is critical to mitigate the scale of health effects of climate pollutants. The Court should be mindful of Congress's decision to provide EPA regulatory authority to address this type of threat to public health. Any retrenchment in the scope of that authority would inflict further harm to the health of current and future generations.

ARGUMENT

I. Anthropogenic climate change, fueled by emissions of greenhouse gases such as carbon dioxide, harms public health in the United States.

The term "anthropogenic climate change" describes the effects caused by elevated concentrations of greenhouse gases, which trap a higher portion of the sun's heat that the Earth radiates back into space, leading to rises in global land and ocean temperatures.[6] In the United States, power plants are "by far" the largest industrial emitters of greenhouse gases. 80 Fed. Reg. at 64,530.

The studies cited in this brief summarize the medical consensus regarding the dire consequences of warming and unstable climate conditions. Report after report establish the escalating toll climate change exacts on public health in the United States. They document the millions of Americans experiencing—and who are predicted to experience—climate change-linked health consequences. Some of these studies measure human health costs in hospitalizations, or

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[6] *See, e.g.*, U.S. Environmental Protection Agency, *Causes of Climate Change*, https://www.epa.gov/climatechange-science/causes-climate-change (last visited January 12, 2022).

missed school and work days.[7] Others, evaluate them economically in billions of real dollars.[8] Still others, determine them by quantifying lives shortened and lives lost.[9]

A. Climate change increases heat-related illnesses, hospitalizations, and death.

Climate change results in higher ambient temperatures[10] and more "heat waves," unusually hot weather that exceeds regional averages for two or more days,[11] among other physical transformations.

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[7] Neal Fann et al., *The geographic distribution and economic value of climate-change ozone health impacts in the United States in 2030*, 65 J. of the Air & Waste Mgmt. Ass'n 570, 574 (2015).

[8] *See, e.g.*, Kim Knowlton et al., *Six Climate Change-Related Events in the United States Accounted for About $14 Billion In Lost Lives and Health Costs*, 30 Health Aff. 2167, 2168 (2011).

[9] Drew Shindell et al., *The Effects of Heat Exposure on Human Mortality Throughout the United States*, 4 GeoHealth 1, 7 (2020) (examining impacts of projected climate change, and estimating that during the 2010 decade, 12,000 premature U.S. heat-related deaths occurred annually).

[10] *See, e.g.*, David H. Levinson & Christopher J. Fettig, *Climate Change: Overview of Data Sources, Observed and Predicted Temperature Changes, and Impacts on Public and Environmental Health*, in Global Climate Change and Public Health 31, 33–36 (Kent E. Pinkerton & William N. Rom eds., 2014) (summarizing leading research on past and projected increases in ambient temperatures).

[11] Tiffany T. Smith et al., *Heat waves in the United States: definitions, patterns, and trends*, 118 Climatic Change 811, 812–14 (2013); A. Haines et al., *Climate change and human health: impacts, vulnerability, and mitigation*, 367 Lancet 2101, 2102 (2006) (concluding that human influence on climate has at least doubled the risk of major heat waves).

The northern hemisphere is warming faster than the rest of the world, with the northeast suffering the swiftest warming in the contiguous United States.[12] The connection between rising temperatures and health is direct and deadly.[13] Decades of data from Georgia to Washington State demonstrate that intensifying heat resulting from climate change increases emergency room visits for cardiac, pulmonary, and kidney failures, as well as stroke, asthma attacks, and diabetes complications.[14] Even relatively short exposure to extreme heat events is associated with an elevated hourly heart attack rate.[15]

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[12] Ambarish V. Karmalkar & Raymond S. Bradley, *Consequences of Global Warming of 1.5°C and 2°C for Regional Temperature and Precipitation Changes in the Contiguous United States*, 12 PLOS ONE e0168697 (2017).

[13] Shakoor Hajat & Tom Kosatky, *Heat-related mortality: a review and exploration of heterogeneity*, 64 J. Epidemiology & Cmty. Health 753, 754 (2010) (determining that risk of mortality in various cities increased by 1-3 percent with each degree-Centigrade increase in temperature); Mercedes Medina-Ramón & Joel Schwartz, *Temperature, temperature extremes, and mortality: a study of acclimatisation and effect modification in 50 US cities*, 64 J. Occupational & Envtl. Med. 827, 829 (2007) (identifying causal relationship based on over six million observations).

[14] Tianqi Chen et al., *Time-series Analysis of Heat Waves and Emergency Department Visits in Atlanta, 1993 to 2012*, 125 Envtl. Health Persp. 057009 (2017); Tania Busch Isaksen et al., *Increased hospital admissions associated with extreme-heat exposure in King County, Washington, 1990-2010*, 30 Rev. Envtl. Health (2015).

[15] Sebastian T. Rowland et al., *Can ultra short-term changes in ambient temperature trigger myocardial infarction?*, 143 Env't Int'l 105910, 105916 (2020).

Premature heat-related deaths in the contiguous U.S. are estimated at 12,000 per year.[16] Certain risk factors exacerbate the mortality impacts of heat waves. Large segments of the U.S. population with common pre-existing health conditions, especially the very young or the elderly, are at heightened risk[17] as "[m]ost heatwave deaths occur in people with . . . cardiovascular . . . or chronic respiratory diseases."[18] Residents in urban areas also suffer from the "heat island" effect of concrete surfaces heating faster and holding heat longer than vegetation and water surfaces prevalent in non-urban areas.[19] And populations living in locations with historically lower temperatures often lack air conditioning and other adaptations, and thus experience higher mortality rates from heat waves.[20]

Heat waves and higher temperatures also cause a number of other serious health effects. One effect is

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[16] *See, e.g.*, Shindell et al., *supra* note 9, at 7.

[17] *See, e.g.*, Rupa Basu, *High ambient temperature and mortality: a review of epidemiologic studies from 2001 to 2008*, 8 Envtl. Health 40 (2009) (determining that the groups most vulnerable to elevated heat-related deaths included infants and young children, and those over 65).

[18] Anthony J. McMichael et al., *Climate change and human health: present and future risks*, 367 Lancet 859, 861 (2006).

[19] *See id.* ("Thermally inefficient housing and the so-called urban heat island effect . . . amplify and extend the rise in temperatures (especially overnight)"); Clare Heaviside et al., *The Urban Heat Island: Implications for Health in a Changing Environment*, 4 Current Envtl. Health Rep. 296 (2017).

[20] William N. Rom & Kent E. Pinkerton, *Introduction: Consequences of Global Warming to the Public's Health*, in Global Climate Change and Public Health 1, 10 (Kent E. Pinkerton & William N. Rom eds., 2014).

"heat stress," when the body receives heat "in excess of what it can tolerate without physiological impairment."[21] U.S. labor productivity impairment from heat stress is projected to double between 1995 and 2030.[22] "The expected productivity loss in 2030 is equivalent to 389,000 full-time jobs . . . concentrated in the southern states . . . and concern[ing] mostly outdoor workers, such as construction workers and farm[ers] . . . ."[23]

Other health harms associated with heat waves and higher temperatures include heat stroke,[24] adverse birth outcomes for pregnant women,[25] and

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[21] Tord Kjellstrom et al., *Heat, Human Performance, and Occupational Health: A Key Issue for the Assessment of Global Climate Change Impacts*, 37 Ann. Rev. Pub. Health 97, 98 (2016).

[22] International Labour Organization, *Working on a warmer planet: The impact of heat stress on labour productivity and decent work*, 43 (2019).

[23] *Id.*

[24] R. Sari Kovats & Shakoor Hajat, *Heat Stress and Public Health: A Critical Review*, 29 Ann. Rev. Pub. Health 41, 42, 47 (2008) (noting danger of and risk factors for heat stroke); Helene G. Margolis, *Heat Waves and Rising Temperatures: Human Health Impacts and the Determinants of Vulnerability*, in Global Climate Change and Public Health, 85, 97-100 (Kent E. Pinkerton & William N. Rom eds. 2014) (describing pathways through which high temperatures can lead to adverse health outcomes).

[25] Bruce Bekkar et al., *Association of Air Pollution and Heat Exposure with Preterm Birth, Low Birth Weight, and Stillbirth in the US: A Systematic Review*, 3 JAMA Network Open e208243 (2020) (providing a review of 57 studies and concluding heat, ozone, and fine particulate matter are all associated with preterm birth, low birth weight, and stillbirth).

decreased lung function.[26] For example, a study of 12.5 million Medicare beneficiaries across 213 U.S. counties found that each 10°F increase in daily temperature was associated with a 4.3 percent increase in same-day emergency hospitalizations for respiratory diseases.[27] Further, extreme heat has significant adverse effects on mental health.[28] Heat waves impair cognition, moods, and sleep,[29] and

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[26] Mary B. Rice et al., *Association of outdoor temperature with lung function in a temperate climate*, 53 Eur. Respiratory J. 1, 1 (2019) (establishing that "1-, 2- and 7-day [higher] average temperatures were all associated with lower lung function."); *see also* Nana Mireku et al. *Changes in weather and the effects on pediatric asthma exacerbations*, 103 Annals of Allergy, Asthma & Immunology 220, 223 (2009).

[27] *See* G. Brooke Anderson et al. *Heat-related Emergency Hospitalizations for Respiratory Diseases in the Medicare Population*, 187 Am. J. Respiratory & Critical Care Med. 1098, 1098 (2013).

[28] Nick Obradovich et al., *Empirical evidence of mental health risks posed by climate change*, 115 Proc. Nat'l Acad. Sci. 10953 (2018) (analyzing meteorological and climatic data, with 2 million U.S. residents between 2002 and 2012 that reported mental health difficulties); Jingwen Liu et al., *Is there an association between hot weather and poor mental health outcomes? A systematic review and meta-analysis*, 153 Env't Int'l 106533 (2021).

[29] R. Jisung Park et al., *Learning is inhibited by heat exposure, both internationally and within the United States,* 5 Nature Human Behavior 19 (2020); Nick Obradovich et al., *Nighttime temperature and human sleep loss in a changing climate*, 3 Sci. Advances. E1601555 (2017) (noting the "integral role" temperature plays in sleep function and reporting on "anomalous nighttime temperatures harm[ing] the sleep quality of individuals").

contribute to increases of aggression and suicide.[30] Without curbing greenhouse gas emissions, ambient temperatures and heat waves will intensify, with profound consequences for human health.[31]

B. Climate change fuels longer and more intense fire seasons.

Wildfires and fires in densely populated areas lead directly to loss of life and property, and are increasing in frequency, duration, and intensity.[32] Multiple studies conclude that worsening fire seasons are largely attributable to climate change, due to increases in temperatures and aridity, and earlier snowmelt.[33] The United States became significantly

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[30] Marshall Burke et al., *Climate and Conflict*, 7 Annual Rev. Econ. 577 (2015); Marshall Burke et al., *Higher Temperatures increase suicide rates in the United States and Mexico*, 8 Nature Climate Change 723 (2018).

[31] Roger D. Peng et al., *Toward a Quantitative Estimate of Future Heat Wave Mortality under Global Climate Change*, 119 Envtl. Health Persp. 701, 701 (2011) ("The impact of future heat waves on human health will likely be profound, and significant gains can be expected by lowering future carbon dioxide emissions.").

[32] *See, e.g.*, Philip E. Dennison et al., *Large wildfire trends in the western United States, 1984-2011*, 41 Geophys. Res. Letters 2928 (2014) (finding number of large U.S. fires increasing); Jeremy S. Littell et al., *Climate and wildfire area burned in western U.S. ecoprovinces, 1916-2003*, 19 Ecological Applications 1003 (2009) (finding U.S. area burned in fires increasing); A.L. Westerling et al., *Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity*, 313 Science 940 (2006) (finding U.S. fire season duration increasing).

[33] *See, e.g.*, Mary B. Rice et al., *Respiratory Impacts of Wildland Fire Smoke: Future Challenges and Policy Opportunities*, 18 Annals of the American Thoracic Soc'y 921

more wildfire-prone in the past four decades,[34] with the area burned from wildfires quadrupling.[35] Wildfires release high concentrations of pollutants, including particulate matter and chemical compounds which form ground-level ozone.[36] These pollutants harm populations far from the western United States where fires typically burn, reaching Midwestern and Northeastern states.[37] Indeed, as of 2017, an estimated 10 percent of the U.S. population,

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(2021) (observing wildfire activity increases are largely attributable to climate change rather than land use or forest management); John T. Abatzoglou & A. Park Williams, *Impact of anthropogenic climate change on wildfire across western US forests*, 42 Proc. Nat'l Acad. Sci. 11770, 11770 (2016) ("human-caused climate change caused over half of the documented increases in fuel aridity since the 1970s and doubled the cumulative forest fire area since 1984").

[34] *See* Dennison et al., *supra* note 32, at 2932-33; Steven W. Running, *Is Global Warming Causing More, Larger Wildfires?*, 313 Science 927, 927 (2006) (reporting a fourfold increase in major American wildfires since 1986).

[35] Marshall Burke et al., *The changing risk and burden of wildfire in the United States*, 118 Proc. Nat'l Acad. Sci. e2011048118 (2021).

[36] Jennifer D. Stowell et al., *Associations of wildfire smoke $PM_{2.5}$ exposure with cardiorespiratory events in Colorado 2011-2014*, 133 Env't Int'l 105151 (2019) (demonstrating that increased exposure to wildfire-derived $PM_{2.5}$ was associated with increased respiratory hospitalizations, when separating out background PM); Daniel A. Jaffe & Nicole L. Wigder, *Ozone production from wildfires: A critical review*, 51 Atmospheric Env't 1, 2, 7 (2012).

[37] *See, e.g.*, Katelyn O'Dell et al., *Estimated Mortality and Morbidity Attributable to Smoke Plumes in the United States: Not Just a Western US Problem*, 5 GeoHealth e2021GH000457 (2021).

approximately 30.5 million people, reside where wildfire can contribute a significant burden to their exposure to fine particulate matter.[38]

Wildfire-generated particulate matter increases respiratory and cardiac hospitalizations. For example, studies in Colorado demonstrate marked escalation in emergency visits and hospitalizations for asthma from wildfire-generated particulate matter.[39] There is also strong evidence that exposure to particulate matter increases risk of death, even for those without preexisting conditions.[40] Further, the growing severity and frequency of weather-related climate disasters harm mental health, as well, when wildfires and storms destroy homes and communities.[41] Responses range from post-traumatic stress disorder, to new

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[38] A.G. Rappold et al., *Community Vulnerability to Health Impacts of Wildland Fire Smoke Exposure*, 51 Envtl. Sci. & Tech. 6674, 6674 (2017).

[39] Stowell et al., *supra* note 36.

[40] Ana G. Rappold et al., *Cardio-respiratory outcomes associated with exposure to wildfire smoke are modified by measures of community health*, 11 Envtl. Health 71, 71 (2012); Johanna Lepeule et al., *Chronic Exposure to Fine Particles and Mortality: An Extended Follow-up of the Harvard Six Cities Study from 1974 to 2009*, 120 Envtl. Health Persp. 965, 968 (2012).

[41] *See* Isobel Braithwaite et al., *Air Pollution (Particulate Matter) Exposure and Associations with Depression, Anxiety, Bipolar, Psychosis and Suicide Risk: A Systematic Review and Meta-Analysis*, 127 Envtl. Health Persp. 126002 (2019) (finding ozone and particulate matter exposure is linked to increased incidence of depression, anxiety, and dementia).

onset or exacerbation of psychiatric disorders, to complex grief, among other disorders.[42]

C. Climate change impairs air quality by increasing pollen and ground level ozone.

1. Pollen

Climate change is the dominant driver of the United States' lengthening pollen season and a significant contributor to increasing pollen concentrations.[43] Warmer temperatures lengthen pollen seasons because plants bloom earlier and for longer periods of time.[44] In addition, climate change's meteorological effects include more frequent and severe thunderstorms, which cause sudden pollen releases[45] and break pollen into smaller particles,

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[42] Katie Hayes et al. *Climate change and mental health: risks, impacts and priority actions*, 12 Int'l J. Mental Health Sys. 28 (2018).

[43] *See, e.g.*, William R.L. Anderegg et al., *Anthropogenic climate change is worsening North American pollen seasons*, 118 Proc. Nat'l Acad. Sci. e2013284118 (2021); L.H. Ziska & D. Berman, *Impact of Climate Change on Aeroallergenic Pollen Metrics: A Hemispheric Perspective*, 33 Current Allergy & Clinical Immunology 93 (2020); Yong Zhang et al., *Allergenic pollen season variations in the past two decades under changing climate in the United States*, 21 Global Change Biology 1581, 1583-86 (2015).

[44] Lewis Ziska et al., *Recent warming by latitude associated with increased length of ragweed pollen season in central North America*, 108 Proc. Nat'l Acad. Sci. 4248, 4248 (2011) (documenting that between 1995 and 2009, the ragweed pollen season lengthened by 13-27 days above the forty-fourth parallel, which encompasses portions of the United States).

[45] Shuaib M. Nasser & Thomas B. Pulimood, *Allergens and Thunderstorm Asthma*, 9 Current Allergy & Asthma Rep. 384, 387-88 (2009).

enabling its allergens to penetrate deeper into the lungs.[46] The predictable result: more asthma attacks and more emergency room visits.[47]

Like the heat-related dangers described above, the impacts of pollen are more severe for people with pre-existing health conditions. Longer and more intense allergy seasons pose a substantial threat to the approximately 25.1 million Americans with asthma,[48] because pollen triggers attacks in asthmatics who are allergic to pollen.[49] Nearly nine percent of the nation's school age children have asthma.[50] Asthma exacerbations keep children out of

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[46] Andrew Rorie & Jill A. Poole, *The Role of Extreme Weather and Climate-Related Events on Asthma Outcomes*, 41 Immunology & Allergy Clinics N. Am. 73 (2021).

[47] James E. Neumann et al., *Estimates of Present and Future Asthma Emergency Department Visits Associated with Exposure to Oak, Birch, and Grass Pollen in the United States*, 3 GeoHealth 11, 24 (2019) (determining health impacts for exposure to current and potential future pollen loads under multiple climate scenarios).

[48] Centers for Disease Control & Prevention, *Most Recent National Asthma Data*, Ctrs. for Disease Control & Prevention https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm (last accessed January 18, 2022).

[49] Clarisse Gautier & Denis Charpin, *Environmental triggers and avoidance in the management of asthma*, 10 J. Asthma & Allergy, 47 (2017); Susan C. Anenberg et al., *Impacts of oak pollen on allergic asthma in the United States and potential influence of future climate change*, 1 GeoHealth 80, 90 (2009).

[50] Centers for Disease Control and Prevention, *supra* note 48 (calculating the number of children 5-17 in the U.S. with asthma).

school and adults out of work.[51] Recurrent exacerbations can cause permanent airway damage and often require costly medical care.[52]

2. Ground-Level Ozone

Warmer temperatures that come with higher atmospheric concentrations of greenhouse gases increase ground-level ozone.[53] Ground-level ozone is created through a photochemical reaction between nitrogen oxides, volatile organic compounds, heat and sunlight.[54] It causes difficulty breathing, coughing and shortness of breath, and contributes to respiratory-related death.[55]

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[51] Susan M. Pollart et al., *Management of Acute Asthma Exacerbations*, 84 Am. Family Physician 40, 43 (2011); Mary E. Strek, *Difficult Asthma*, 3 Proc. Am. Thoracic Soc'y 116, 118 (2006).

[52] Gary S. Rachelefsky, *From the Page to the Clinic: Implementing New National Asthma Education and Prevention Program Guidelines*, 9 Clinical Cornerstone 9, 9–10 (2009).

[53] Fann et al., *supra* note 7, at 570 ("Climate change can affect air pollutant concentrations in a myriad of ways. Meteorological factors, such as temperatures, cloudiness, precipitation frequency and intensity, . . . all . . . influence air quality by determining photochemical reaction rates . . . ."); I.S.A. Isaksen et al., *Atmospheric composition change: Climate-Chemistry interactions*, 43 Atmospheric Env't 5138, 5169 (2009).

[54] Fann et al., *supra* note 7, at 570.

[55] Ander Wilson et al., *Climate change impacts on projections of excess mortality at 2030 using spatially varying ozone–temperature risk surfaces*, 27 J. Exposure Sci. & Envtl. Epidemiology 118, 118–124 (2017) (modeling ozone-related mortality due to projected changes in climate conditions); Jennifer D. Stowell et al., *The impact of climate change and emissions control on future ozone levels: Implications for human*

People suffering from pre-existing lung disease, and children with still-developing lungs, are especially susceptible to the harmful effects of ozone exposure. Even modest and relatively brief increases in ground-level ozone are linked to an elevated risk of hospitalization for patients with asthma and chronic obstructive pulmonary disease.[56] Tens of thousands of additional ozone-related premature deaths and illnesses are predicted to occur by 2030 if emission controls are not adopted.[57]

D. Climate change leads to increased flooding and degraded water quality.

Climate change-linked higher temperatures lead to more extreme rainfall over short periods of time, producing dangerous floods.[58] "[W]armer air is capable of holding more water than cooler air, and therefore

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health, 108 Env't Int'l 41, 41 (2017) (discussing health benefits of emissions mitigation).

[56] *See* Benedicte Jacquemin et al., *Air pollution and asthma control in the Epidemiological study on the Genetics and Environment of Asthma*, 66 J. Epidemiology Cmty. Health 796, 796-802 (2012); Kelly Moore et al., *Ambient Ozone Concentrations Cause Increased Hospitalizations for Asthma in Children: An 18-Year Study in Southern California*, 116 Envtl. Health Persp. 1063, 1063-70 (2008).

[57] *See* Fann et al., *supra* note 7, at 570; *see also* Kim Knowlton et al., *Assessing Ozone-Related Health Impacts under a Changing Climate*, 112 Envtl. Health Persp. 1557, 1559-60, 1562 (2004) (estimating significant increase in mortality as a result of increase in ground-level ozone attendant to climate change).

[58] Seth Westra et al., *Future changes to the intensity and frequency of short-duration extreme rainfall*, 52 Rev. Geophysics 522, 522-25 (2014).

has the potential to provide more moisture to rainfall events."[59] Extreme floods in the United States have increased by more than twenty percent in recent decades in some regions.[60] For example, "heat stress events," in which an environment is struck by high temperatures and humidity, preceded a high percentage of recent floods in Iowa, Illinois, and Indiana.[61]

The potential effects of heat stress-linked floods include fatalities and the destruction of communities and critical infrastructure.[62] For example, climate-related flooding can damage roads, hospitals, and the nation's power grid.[63] The health effects and costs are likewise significant. For instance, a 2011 study measured the health costs of river flooding.[64] Floods in North Dakota from severe storms and near-record snow accumulation and rapid melting, exacted

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[59] *Id.* at 523.

[60] Wouter R. Berghuijs et al., *Recent changes in extreme floods across multiple continents*, 12 Envtl. Res. Letters 114035, 114038 (2017) (estimating increases in the occurrence of extreme floods by region throughout the world).

[61] *See* Wei Zhang & Gabriele Villarini, *Deadly Compound Heat Stress-Flooding Hazard Across the Central United States*, 47 Geophysical Res. Letters 1, 6 (2020) ("There is a clear connection between heat stress and flooding . . . . The new compounding extreme exhibits a strong signal, especially in Iowa, Illinois, and Indiana, which are frequently affected by stormy weather during the summer.").

[62] *Id.*

[63] *Id.*

[64] Knowlton et al., *supra* note 8.

approximately $145,495 in health costs per 1,000 people in the area affected.[65]

The cascading impacts of climate change-fueled flooding include illnesses from microbial growth. After Hurricanes Katrina and Rita made landfall in 2005, water inundated 80 percent of New Orleans for more than two weeks.[66] Even as floodwaters receded, additional threats emerged. The flooding's duration, coupled with warm temperatures in the late Louisiana summer, spawned mold in thousands of homes.[67] Exposure to mold is associated with respiratory illnesses, placing immunocompromised people at risk for fungal colonization and opportunistic infections.[68] For example, following floods in North Dakota and North Carolina, public health workers reported mold-

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[65] *Id.* at 2169-70.

[66] *See* Margaret A. Riggs et al., *Resident cleanup activities, characteristics of flood-damaged homes and airborne microbial concentrations in New Orleans, Louisiana, October 2005*, 106 Envtl. Res. 401, 402 (2005). Climate change also increases the intensity of hurricanes. *See* Greg Holland & Cindy L. Bruyère, *Recent intense hurricane response to global climate change*, 42 Climate Dynamics 617, 617-19 (2013).

[67] Riggs et al., *supra* note 66, at 404-07.

[68] *Id.* (citing Institute of Medicine, *Damp Indoor Spaces and Health* (2004)). After the floods, families enrolled in a study conducted by a Louisiana asthma association reported moving homes between one and four times to find safe housing. Jill A. Poole et al., *Impact of weather and climate change with indoor and outdoor air quality in asthma: A Work Group Report of the AAAAI Environmental Exposure and Respiratory Health Committee*, 143 J. Allergy Clinical Immunology 1702, 1705 (2019).

linked, post-flooding increases in asthma symptoms, rhinitis, rash, and headaches.[69]

Extreme flooding also diminishes water quality. Increased rain and snow can exceed the capacity of sewer systems.[70] Discharges from domestic, commercial, and industrial sources of waste can then flow directly into surface waters, including rivers, streams, and estuaries.[71] These discharges in turn impair water quality, expose people to untreated sewage, and lead to basement backups of sewage in residential homes.[72] These exposures cause gastrointestinal illness and other waterborne diseases.[73] River flooding further degrades water quality by raising the rates of dissolved nitrogen, phosphorus, and suspended solids, as well as overwhelming wastewater treatment plants.[74] Ample data indicate that as climate change-linked flooding

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[69] Riggs et al., *supra* note 66, at 402.

[70] U.S. Environmental Protection Agency, Report to Congress: Combined Sewer Overflows into the Great Lakes Basin (2016), available at https://www.epa.gov/sites/default/files/2016-05/documents/gls_cso_report_to_congress_-_4-12-2016.pdf (accessed January 25, 2022).

[71] *Id.* at 1-2.

[72] *Id.* at 2.

[73] *See, e.g.*, Jonathan A. Patz et al., *Climate Change and Waterborne Disease Risk in the Great Lakes Region of the U.S.*, 35 Am. J. Preventive Med. 451, 455 (2008).

[74] Thomas C. Peterson et al., *Changes in weather and climate extremes: State of knowledge relevant to air and water quality in the United States*, 64 J. Air & Waste Mgmt. Assoc. 184, 191 (2014).

worsens, its human health costs are likely to multiply.[75]

E. Climate change leads to increased vector-borne diseases.

Vector-borne diseases result from infections transmitted by mosquitoes and ticks. The expanding range of both mosquitoes and ticks, and the pathogens they carry, is attributable to an array of human-induced changes, including climate change. Temperatures are central to mosquito physiology and mortality, to their host behavior, and to the incubation of pathogens within the mosquito.[76] Warmer weather thus enables mosquitoes to expand their range.[77]

Over the last several decades, the expanded range of multiple mosquito species facilitated the spread of serious vector-borne diseases into the United States. Physicians attribute the recent proliferation of mosquito-borne illnesses such as Zika—which causes fetal neurological complications and birth defects including microcephaly—to rising global surface

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[75] Stephane Hallegatte et al., *Future flood losses in major coastal cities*, 3 Nature Climate Change 802, 804-05 (2013).

[76] Michael A. Robert et al., *Climate change and viral emergence: Evidence from* Aedes*-borne arboviruses*, 40 Current Opinion Virology 41, 42 (2020).

[77] *See* Ilia Rochlin et al., *Climate Change and Range Expansion of the Asian Tiger Mosquito (Aedes Albopictus) in Northeastern USA: Implications for Public Health Practitioners*, 8 PLOS ONE e60874 (2013). Climate change-influenced extreme weather events also produce conditions in which water-, mosquito-, and rodent-borne diseases can thrive. *See, e.g.*, Paul Epstein, *The ecology of climate change and infectious diseases: comment*, 91 Ecology 925 (2010).

temperatures and new variability in rainfall.[78] In fact, although Zika became transmissible to humans around 1950, the United States had no reported local transmissions until 2016.[79]

Dengue is another mosquito-borne illness with a recently-expanded range.[80] Previously limited to subtropical and tropical regions, Dengue outbreaks now occur in Hawaii, Florida, and Texas.[81] Strikingly, the range of the Dengue-carrying mosquito has now grown to include the entire southeast and much of the southwestern United States.[82]

The introduction of the West Nile Virus into the United States is also linked to climate, particularly the proliferation of warm and wet conditions.[83] It is now the most prevalent mosquito-borne disease in the United States.[84] West Nile Virus can attack the central

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[78] Robert et al., *supra* note 76, at 41-44.

[79] Nathan D. Grubaugh et al., *Genomic epidemiology reveals multiple introductions of Zika virus into the United States*, 546 Nature 401, 401-02 (2017).

[80] Robert et al., *supra* note 76, at 42 (observing an expansion of Dengue in the last 20 years).

[81] *Id.*

[82] Centers for Disease Control and Prevention, *Potential Range of the* Aedes aegypti *and* Aedes albopictus *in the United States, 2017*, Ctrs. for Disease Control & Prevention, available at https://www.cdc.gov/mosquitoes/mosquito-control/professionals/range.html (accessed January 2, 2022).

[83] Epstein, *supra* note 77, at 927.

[84] Carolyn A. Reimann et al., *Epidemiology of Neuroinvasive Arboviral Disease in the United States, 1999-2007*, 79 Am. J. Tropical Med. Hygiene 974, 974 (2008).

nervous system, necessitating hospitalization, and sometimes causing death.[85]

Mosquitoes are not the only disease-inducing pest with an enlarged range. The habitats of several tick species are growing throughout the United States in response to increased temperatures.[86] This warming trend contributes to tick species' decades-long encroachment to the north and west.[87] Ticks cause almost 95 percent of all vector-borne diseases reported annually in the United States, including Lyme disease and Rocky Mountain spotted fever, among others.[88]

In short, as temperatures rise, the range of environments suitable for disease-carrying species grows.[89] In the absence of effective regulation, regions affected by vector-borne illnesses are likely to expand, new vector-borne diseases may emerge, and existing vector-borne diseases may increase.[90]

II. Climate change severely harms the health of vulnerable populations.

The health harms and costs of climate pollutants fall heavily on vulnerable populations. Young children and pregnant women, adults older than sixty-five, and communities of color and low income are most

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[85] *Id.*

[86] Daniel E. Sonenshine, *Range Expansion of Tick Disease Vectors in North America: Implications for Spread of Tick-Borne Disease*, 15 Int'l J. Envtl. Res. Pub. Health 478 (2018).

[87] *Id.*

[88] *Id.* at 478.

[89] *See* Rochlin et al., *supra* note 77, at 1-2.

[90] Robert, *supra* note 76.

vulnerable to and severely harmed by the adverse health impacts of climate change.[91]

Children, particularly infants, are more susceptible to climate change-related temperature increases and heat waves because they cannot regulate body temperature as well as adults.[92] Children are also at heightened risk from air pollution because they spend more time outdoors, have higher respiratory rates, and have developing organs and immune systems.[93] Exposure of children to air pollutants is associated with reduced lung function, new onset asthma, exacerbation of chronic respiratory illnesses,[94] cognitive and developmental disorders

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[91] *See, e.g.*, Yunquan Zhang et al., *Socio-geographic disparity in cardiorespiratory mortality burden attributable to ambient temperature in the United States*, 26 Envtl. Sci. & Pollution Res. Int'l 694, 698 (2019).

[92] Kim Knowlton et al., *The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits*, 117 Envtl. Health Persp. 61, 61 (2009) (observing greater risk of heat-related emergency department visits for children ages 0–4); Aaron S. Bernstein & Samuel S. Myers, *Climate change and children's health*, 23 Current Opinion in Pediatrics 221, 222 (2011).

[93] Heather L. Brumberg et al., *Ambient Air Pollution: Health Hazards to Children*, 147 Pediatrics e2021051484 (2021).

[94] *Id.*; Gennaro D'Amato et al., *Urban Air Pollution and Climate Change as Environmental Risk Factors of Respiratory Allergy: An Update*, 20 J. Investigational Allergology & Clinical Immunology 95 (2010).

including autism and attention deficit/hyperactivity disorder,[95] and asthma-related hospitalizations.[96]

The risk of severe heat complications for pregnant women and infants also escalates with temperature increases.[97] One 2019 study based on 32 million births across 403 U.S. counties established that exposure to extreme heat is associated with an increased risk of preterm birth, the second leading cause of death in children under five.[98] Further, heat waves during pregnancy are correlated with increased maternal stress and, consequently, babies with abnormal conditions related to maternal stress.[99] In addition, higher incidences of wildfires are dangerous for pregnant women, and infants with developing

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[95] Oddvar Myhre et al., *Early life exposure to air pollution particulate matter (PM) as risk factor for attention deficit/hyperactivity disorder (ADHD): Need for novel strategies for mechanisms and causalities*, 354 Toxicology & Applied Pharmacology 196 (2018); Andrea L. Roberts et al., *Perinatal Air Pollutant Exposures and Autism Spectrum Disorder in the Children of Nurses' Health Study II Participants*, 121 Envtl. Health Persp. 978 (2013).

[96] *See, e.g.*, Mireku et al., *supra* note 26, at 223-24; Katherine Shea, *Global Climate Change and Children's Health*, 120 Pediatrics 1359, 1362-63 (2007).

[97] Bekkar et al., *supra* note 25.

[98] Shengzhi Sun et al., *Ambient temperature and preterm birth: A retrospective study of 32 million US singleton births*, 126 Env't Int'l 7, 7, 12 (2019).

[99] Gulcan Cil & Trudy Anne Cameron, *Potential Climate Change Health Risks from Increases in Heat Waves: Abnormal Birth Outcomes and Adverse Maternal Health Conditions*, 37 Risk Analysis 2066, 2066 (2017) (examining adverse conditions such as fetal distress and reliance on a ventilator at birth).

lungs and brains.[100] Wildfire smoke exposure during pregnancy is associated with low birth weight and preterm birth.[101]

Climate change also presents more serious health threats to people 65 and older.[102] People over 65 are at greater risk of having a pre-existing condition that renders climate co-morbidity more likely. For example, older people are more likely to be hospitalized or to die from high temperatures and heat waves.[103] This population has marginal cardio-respiratory reserves to cope with heat and air

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[100] *See, e.g.*, Sam Heft-Neal et al., *Associations between wildfire smoke exposure during pregnancy and risk of preterm birth in California*, 203 Envtl. Res. 111872 (2022) (analyzing data on singleton births and PM exposure to "estimate 6,974 . . . excess preterm births attributable to wildfire smoke exposure 2007-2012" in California).

[101] Sana Amjad et al., *Wildfire exposure during pregnancy and the risk of adverse birth outcomes: A systematic review*, 156 Env't Int'l 106644 (2021).

[102] Rice et al., *supra* note 33, at 923; Carina J. Gronlund et al., *Vulnerability to renal, heat and respiratory hospitalizations during extreme heat among U.S. elderly*, 136 Climatic Change 631 (2016). *See also* Gill Livingston et al., *Dementia prevention, intervention and care: 2020 report of the Lancet Commission*, 396 Lancet Commissions 413 (2020) (describing the risk of dementia from exposure to pollutants associated with climate change).

[103] Ambarish Vaidyanathan et al., *Heat-Related Deaths – United States, 2004-2018*, 69 Morbidity & Mortality Wkly. Rep. 729, 729 (2020); Janet L. Gamble et al., *Climate Change and Older Americans: State of the Science*, 121 Envtl. Health Persp. 15, 17 (2013).

pollution, placing them at risk for more frequent acute cardiovascular and respiratory illnesses.[104]

But age is not the only predictor of climate change health effects. Race and income are significant predictors of these risks.[105] In a study tracking more than a decade of heat-related adult deaths in New York City, researchers found that Black adults and those living in census tracts receiving greater public assistance were most likely to die during heat waves.[106] In the western wildfire context, studies also establish that Black individuals are at significantly higher risk of respiratory-related hospital admissions on high smoke days.[107]

Communities of color are not just at a heightened risk of health impacts from climate pollutants. Often they experience a disproportionate burden of multiple health stressors. The disparities in exposure to air

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[104] Antonella Zanobetti et al., *Summer temperature variability and long-term survival among elderly people with chronic disease*, 109 Proc. Nat'l Acad. Sci. 6608, 6609 (2012); Anderson et al., *supra* note 27, at 1098.

[105] *See, e.g.*, Zhang et al., *supra* note 91, at 694.

[106] Jaime Madrigano et al., *A Case-Only Study of Vulnerability to Heat Wave-Related Mortality in New York City (2000-2011)*, 123 Envtl. Health Persp. 672, 672 (2015) ("Compared with other warm-season days, deaths during heat waves were more likely to occur in black (non-Hispanic) individuals than other race/ethnicities, . . . and more likely among those living in census tracts that received greater public assistance . . . .").

[107] Jia Coco Liu et al., *Who Among the Elderly Is Most Vulnerable to Exposure to and Health Risks of Fine Particulate Matter From Wildfire Smoke?*, 186 Am. J. Epidemiology 730 (2017).

pollution at home and at school by race and ethnicity is documented in several studies.[108] As a result, residents in these communities suffer elevated rates of conditions that render them more vulnerable to health harms from climate change, such as asthma, chronic airway diseases, and cardiovascular disease.[109] These communities, then, along with children, infants, pregnant women, and those over 65, are at the greatest risk if greenhouse gas emissions are not regulated and reduced.

III. The Clean Air Act empowers EPA to take regulatory action to protect the public from adverse health effects due to climate change.

The purpose of the Clean Air Act is "to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare . . . ." 42 U.S.C. § 7401(b)(1). Public health was of paramount importance to Congress in drafting and amending the CAA. Senator Edmund Muskie, the Senate architect of the legislation, said the Act would "protect the public health," noting that the costs of air pollution included "death, disease, and disability." 116 CONG.

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[108] *See, e.g.*, Jonathan Colmer et al., *Disparities in $PM_{2.5}$ air pollution in the United States*, 369 Science 575 (2020); Jayajit Chakraborty & Paul A. Zandbergen, *Children at risk: measuring racial/ethnic disparities in potential exposure to air pollution at school and home*, 61 J. Epidemiology & Cmty. Health 1074 (2017); Eric B. Brandt et al., *Air pollution, racial disparities, and COVID-19 mortality*, 146 J. Allergy & Clinical Immunology 61, 62 (2020) ("Lower income communities of color are more likely to have historical exposures to higher levels of air pollution.").

[109] Brandt, *supra* note 108, at 61.

REC. S20,597-611 (1970).[110] The text of the CAA is replete with mandates for EPA to consider public health in its decision-making and to protect public health with its actions. *See* 42 U.S.C. §§ 7408-09 (air quality criteria and national ambient air quality standards); § 7411 (standards of performance for new stationary sources); § 7412 (hazardous air pollutants); § 7470 (prevention of significant deterioration); § 7521 (emission standards for new motor vehicles). This Court's decisions also reflect the Act's textual commitment to public health. *See, e.g.*, *Whitman v. American Trucking Ass'n*, 531 U.S. 457, 465-71 (2001).

Accordingly, from the earliest days of CAA implementation, EPA regulated power plants because they pose an array of risks to public health. *See, e.g.*, 36 Fed. Reg. 5931 (Mar. 31, 1971) (memorializing EPA's 1971 decision that coal-fired generators fit under sources to be regulated by Section 111 because they "[contribute] significantly to the endangerment of public health or welfare.") And more than a decade ago, EPA concluded that greenhouse gases from automobiles, also emitted from power plants, threatened the public health and welfare of current and future generations. 74 Fed. Reg. 66,496 (Dec. 15, 2009).

Regulation and reduction of greenhouse gas emissions are necessary to mitigate the scale of intensifying public health harms associated with climate change. The need is urgent, and the quality and length of lives are at stake. The Court should

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[110] In introducing the Senate legislation for the 1990 CAA amendments, Senator Lincoln Chafee emphasized, "[t]his is a health bill . . . ." 136 CONG. REC. S16895-01 (1990).

affirm EPA's ability to carry out its mandate to protect public health by regulating carbon dioxide emissions from power plants.

CONCLUSION

The judgment of the court of appeals should be affirmed.

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