Climate Change and Physiatry

A Call to Proportional and Prospective Action

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Abstract: Through increased temperature-related illness, exposure to wildfire smoke and air pollutants, and more frequent and intense natural disasters, climate change is disproportionately affecting the health of people with disabilities. Although the evidence behind the health effects of climate change is growing, there remain critical research gaps in the physiatric literature that must be addressed. Increased education throughout the medical-education continuum is also needed to prepare physiatrists to address the climate-related health effects impacting their patient populations. Physiatrists and their member organizations should advocate for policies that address climate change with a focus on the unique needs of their patient population and the inclusion of people with disabilities in the policy making process.

Key Words: Association of Academic Physiatrists, Climate Change, Physiatric Medicine, Position Statement, Graduate Medical Education, Advocacy, Natural Disasters

(*Am J Phys Med Rehabil* 2022;101:988–993)

Climate change is considered the greatest threat to global health of the 21st century.[1] Rising heat, climate variability, natural disaster frequency and severity, and pollution due to wildfire smoke are threatening health at increasing rates. People with disabilities comprise approximately one billion people (15% of the world's population), and this number is rapidly increasing.[2] People with disabilities are disproportionately affected by the health effects of climate change, and this disparity will worsen without immediate action.[3,4]

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This material is based on work supported (or supported in part) by the Department of Veterans Affairs, Veterans Health Administration, Office of Research and Development, and the Center for Innovations in Quality, Effectiveness and Safety (CIN 13-413, Skelton), and Health Services Research and Development Career Development Award 1 IK2 HX002484 (Skelton).

Financial disclosure statements have been obtained, and no conflicts of interest have been reported by the authors or by any individuals in control of the content of this article.

ISSN: 0894-9115
DOI: 10.1097/PHM.0000000000002017

Not only are people with disabilities more vulnerable to the health effects of climate change, they are also less resilient.[4] Indeed, in July of 2019, the United Nations Human Rights Council adopted a resolution on climate change and the rights of people with disabilities "recognizing that persons with disabilities are among the most adversely affected in an emergency, sustaining disproportionately higher rates of morbidity and mortality, and at the same time being among those least able to have access to emergency support."[5] The ways in which climate change negatively impacts the health of people with disabilities are varied and include an increased risk of heat-related injury due to rising ambient temperatures, cardiopulmonary disease from wildfire smoke and air pollution, and harm from natural disasters due to decreased mobility and dependence on technology and caregiver support.[3,6–12] The indirect effects of climate change include the emergence and changing landscape of infectious disease, which are associated with increased symptom severity in people with disability due to underlying medical conditions and barriers to accessing care.[13,14]

In addition to the direct costs to human health, the economic costs of the health effects of climate change are estimated at more than $800 billion annually in the United States (US) and will only increase with time.[15] These costs come when health care already accounts for more than 17% of gross domestic product (GDP) in the US.[16]

CLIMATE CHANGE AND ITS IMPACT ON PEOPLE WITH DISABILITIES

Heat

The 10 hottest years on record have occurred since 2005, with the 7 hottest years occurring since 2014.[17] Indeed, the globe has warmed a mean of 0.18°C (0.324°F) per decade since 1981, more than twice the mean rate of warming since 1880.[18] This warming has both direct health impacts on vulnerable individuals and indirect health impacts on populations through water supply disruption, food insecurity, and changing the distribution of communicable diseases.[1,14] While keeping global warming less than 1.5°C above preindustrial levels would greatly reduce the catastrophic effects of climate change, every fraction of a degree of warming prevented protects human health.[1]

People with thermoregulation deficits due to neurological disease or age, those with mobility deficits that cannot easily escape heat, or those with cognitive or communication deficits that make it difficult to express symptoms of overheating are particularly vulnerable to heat injuries. For example, people with multiple sclerosis demonstrate elevated resting body temperatures, and uncharacteristically warm weather is associated

with multiple sclerosis exacerbations.[8,19] Environmental heat worsens fatigue and preexisting mobility limitations, further restricting access to cooled communal spaces.[6,7]

Individuals with higher-level spinal cord injury (SCI) demonstrate disturbed thermoregulatory responses due to altered vasodilatory, sudomotor, and shivering responses, and people with all levels of SCI are more vulnerable to changes in environmental temperature due to diminished mobility, sensory dysfunction, and reliance on external devices.[20–22] Impaired temperature regulation may require persons with SCI to spend increased time indoors in the face of rising heat, essentially becoming "climate jailed," and contributing to isolation and worsening mental and physical health.[21,22]

In addition, as temperatures continue to rise, people training outdoors or in nonair-conditioned facilities are expected to face increased risk of exertional heat illness (EHI). More than 9000 EHI events are treated in American student athletes each year.[23] Athletes with disabilities are particularly vulnerable to training in rising heat, and much work remains in optimizing prevention and treatment protocols for EHI for this unique population.[24]

Wildfire Smoke and Air Pollution

Globally, an estimated 6.7 million deaths in 2016 were attributed to air pollution, a number that, without action, is predicted to double by 2050.[25] Wildfire smoke, which contains carbon dioxide, carbon monoxide, particulate matter, complex hydrocarbons, nitrogen oxides, and many of the same toxic and carcinogenic substances as cigarette smoke (benzene, benzo[*a*]pyrene, and dibenz[*a*,*h*]anthracene), is a potent air pollutant.[10]

With increasing drought and heat due to climate change, wildfires are increasing in frequency and size.[10] In fact, the top 10 years with the largest acreage burned across the US have all occurred since 2004, a period closely correlated with the warmest years on record.[26]

Patients with already tenuous respiratory status, such as individuals with SCI or amyotrophic lateral sclerosis, are at particular risk for the cardiopulmonary consequences of particulate pollutants. Short-term exposure to particulate matter from pollution, including wildfire smoke, increases the risk of chronic obstructive pulmonary disease exacerbation and lower respiratory infections.[10] There is growing evidence that long-term wildfire smoke exposure may induce obstructive lung pathology.[11] As respiratory complications remain the leading cause of death for people with SCI, pulmonary exacerbations related to wildfire smoke could prove devastating for this population.[27,28]

Moreover, particulate pollution has been shown to increase the risk of heart disease and stroke, which is particularly concerning for individuals whose disabilities already place them at increased risk for accelerated cardiovascular disease and for whom cardiovascular disease remains a leading cause of mortality.[27,29–32]

Natural Disasters—Hurricanes, Wildfires, and Floods

Natural disasters such as hurricanes, wildfires, and floods are becoming more frequent and more intense because of climate change.[1] People with disabilities face life-threatening obstacles to evacuation and care during disasters, including power outages, flooding, debris, care disruption, limited access to medications and supplies, property damage, displacement, and psychological trauma.[3,12] More than 150,000 people with physical, visual, or learning disabilities were found to be disproportionately impacted by Hurricane Katrina.[33]

In 2020, Shapiro et al.[12] painted a striking picture of the challenges that SCI patients face in the wake of a natural disaster: "Patients living in high-rise buildings may become trapped if elevators are not operating. Propelling wheelchairs around storm debris or through floodwaters is physically demanding and dangerous. Personnel staffing medical shelters lack familiarity with the care needs of this population. Physician offices and outpatient therapy clinics may be closed for weeks, interrupting both routine SCI care and treatment for storm-related medical issues."[12] In addition, supply chain disruption resulting from natural disasters may result in autonomic dysreflexia from lack of bladder management supplies or dangerous withdrawal from abrupt discontinuation of spasticity medications.

Clearly, without advanced planning on both a public health and infrastructure level, people with disabilities face life-threatening obstacles during and after natural disasters. Healthcare providers who encounter people with disabilities, including emergency responders, nurses and nursing aides, and physiatrists must be trained to plan for and manage these events.

Infectious Disease Emergence

Deforestation, a root cause of climate change, is the one of the largest causes of animal habitat loss and changes in migration patterns.[34] Climate change also promotes the redistribution of sea and land animals as they follow the changing habitat that accommodates their thermal tolerance or sustains an important food source.[35,36] These changes in migration patterns result in unforeseen animal-to-animal and animal-to-human contact, with a large potential for the sharing of (previously isolated) pathogens and the outbreak of climate-related zoonotic disease.[35,37,38]

Climate change, and its impact on temperature, rainfall and weather patterns, has also made conditions more favorable to the spread of other infectious diseases.[14,36] Tickborne diseases (Lyme), waterborne diseases (*Vibrio parahaemolyticus*), and mosquito-borne diseases (malaria, Zika, and dengue fever) are examples.[14] Although people with disabilities are not disproportionally affected by infections from these organisms, often their reserve to combat the infection is greatly diminished because of underlying health conditions.

This combination of climate-related zoonotic disease emergence and the changing geographical distribution of existing infectious diseases sets the stage for future outbreaks and pandemics that threaten the health of the global human population.

Looking Forward

As climate change accelerates, physiatrists face the prospect that not only will patients with disabilities be disproportionately impacted but also more people may develop disability from the direct and indirect effects of changing climate. Extreme weather events may lead to more physical trauma. Increased ranges of vector-borne infectious diseases such as Lyme disease and West Nile virus may lead to more neurological sequelae.[14]

Wildfires may directly lead to burn injuries and indirectly lead to increased strokes and heart failure from the cardiovascular sequelae of pollution.[39] Physiatrists need to work together now to educate and prepare people with disabilities to address the future risks posed by climate change.

Physiatry's Contribution to Climate Change and Waste

The healthcare system is one of the largest contributors to emissions and waste in the US. Health care contributes 10% of carbon emissions and 9% of harmful nongreenhouse air pollutants in the US and 4%–6% of carbon emissions globally.[1,40] Producing greater than 4 billion pounds of waste annually, the healthcare industry is the second leading contributor of waste in the US.[41] Intercontinental flights to medical conferences produce 2–5 tonnes of CO_2 per attendee, which already exceeds the 2.3 ton annual personal limit required to prevent the worst effects of climate change.[42]

There is currently minimal published research on the medical specialty of Physical Medicine and Rehabilitation (PM&R)-specific emissions or waste; however, with its many procedures, long inpatient rehab stays, and heavy reliance on disposable equipment (e.g., catheters, wound care supplies), rehabilitation health care likely produces a significant amount of waste, thus increasing CO_2 emissions. This underscores the need for optimizing use of telerehabilitation in PM&R to reduce transportation-related emissions, committing to carbon-neutral medical conferences, increasing recycling of commonly used equipment such as wheelchairs, and systematically conducting research to identify and reduce key waste generators within the specialty.

The Unique Role of Physiatrists

Physiatrists should play a critical role in combating climate-related adverse health impacts by becoming climate collaborators, leaders, educators, advocates, and researchers (CCLEAR).[43]

Climate Collaborators and Leaders—Clinical Care

Physiatrists are trained to lead and support an interdisciplinary team and uniquely positioned to understand the psychosocial and home situations of persons with disabilities. An integrated team can help patients prepare for the complexities of climate change, including developing natural disaster evacuation plans, directing heat and pollution mitigation strategies, encouraging safe exercise practices in a changing climate, and ensuring access to green spaces in collaboration with skilled therapists.

For example, physiatrists can develop disaster evacuation plans for patients with disabilities that emphasize procurement of critical supplies, durable medical equipment, ventilators, and medications. This plan must include the input and education of support staff who intimately understand the nuances of an individual's disability and needs and who are critical to avoiding care disruptions in the face of disasters. Because of training in team-based care coordination for patients with disabilities within a complex medical system, physiatrists are uniquely positioned to learn to provide this service. However, adequately preparing physiatrists to lead in the complex realm of disaster management will require extensive research as well as systematic and comprehensive training for providers, both of which are currently lacking.

Physiatrists understand the physiological, mobility, and psychosocial factors that contribute to risk of heat stroke and can provide simple interventions such as cooling vests and counseling to both patients and caregivers on heat avoidance, hydration, and signs and symptoms of heat injury. Similar reasoning applies to the specific effects of air pollution and wildfire smoke on people with disabilities, where physiatrists are positioned to counsel patients on their increased risk of respiratory compromise and cardiovascular disease. Providers may instruct patients on risk mitigation methods such as minimizing outdoor activities, closing windows and doors, avoiding use of ventilation systems that draw in outside air, installing high-efficiency particulate air filters, and avoiding cooking methods that create indoor smoke during periods of wildfire activity.[10] More research into other mitigating measures, such as providing N95 or N100 particulate respirators to those at particular risk (i.e., SCI or amyotrophic lateral sclerosis patients), is critically needed.

Climate Education

Educating physiatric providers, trainees, and patients will be important in successfully preparing the specialty for the changing climate. In June 2019, the American Medical Association (AMA) adopted a sweeping policy supporting teaching on climate change "in undergraduate, graduate, and continuing medical education such that trainees and practicing physicians acquire a basic knowledge of the science of climate change, can describe the risks that climate change poses to human health, and counsel patients on how to protect themselves from the health risks posed by climate change."[44] Many medical schools and some residencies have begun incorporating climate education into their curriculums.[45–47] However, there currently is no formal climate change training in PM&R residencies, and no major physiatric professional organization has adopted similar policies. Considering the dramatic health consequences people with disabilities face, physiatrists have an obligation to educate current and future providers about climate change throughout the medical-education continuum.

There seems to be an appetite for such education. In a 2019 international survey of SCI providers on their perceptions of the effects of climate change on their patients, more than 85% of respondents were interested in further education. The majority (>57%) believed that climate change was impacting their patient's health; however, respondents from North America were significantly less likely to believe this than those from Asia or Europe ($P < 0.01$).[21] These discrepant beliefs, combined with the reality that the health effects of climate change vary based on geographical location, emphasize the importance of targeted education to prepare all PM&R providers for the climate health crises. Ideal educational campaigns would target providers across all levels of training, from undergraduate through residency and continuing medical education.

Climate Advocacy

The US Department of Health and Human Services recently announced the creation of an Office of Climate Change and Health Equity, an important step in addressing this monumental issue.[48] Moreover, in July, 2019, the United Nations Human Rights Council adopted a resolution on climate change and the rights of people with disabilities.[5] Both the Association

of Academic Physiatrists and the American Academy of Physical Medicine and Rehabilitation have representatives on the Medical Society Consortium on Climate and Health, which is an organization of healthcare providers focused on climate change advocacy. Physiatric societies and individual physiatrists must also join other physician groups dedicated to climate change advocacy to develop and promote policies that reduce physiatry's contribution to waste and emissions and to address the unique needs of our patient population. Table 1 provides a list of valuable extant resources for healthcare practitioners interested in becoming involved in climate advocacy and healthcare sustainability. To protect our patients, physiatrists must advocate for policies that reduce greenhouse gas emissions, increase accessible green spaces, tailor evacuation plans to people with disabilities, and develop robust research into the effects of climate change on persons with disabilities. Examples of just a few of such potential policies include:

- Developing certificates with utility companies for priority turn-on service for all individuals dependent on electricity for life or function.[3]
- Developing processes for ensuring the participation of people with disabilities in all stages of preparedness and response through effective analysis and mapping.[3] Accomplishing this may involve conducting listening tours of these important stakeholders and inclusion of persons with disability in governmental policy advocacy groups.
- Advocating for policies that require nationwide adoption of the National Athletic Trainers' Association Inter-association Task Force (NATA-IATF) guidelines on preventing EHI among all levels of athletes. These heat acclimatization policies may need to be regionally adjusted, as exposure to regional climatic differences may make athletes accustomed to cooler climates more vulnerable to EHI when they are exposed to hotter environments.[49]
- Reducing medical waste by focusing on green supply chain purchasing, reusing medical supplies such catheters, minimizing disposable procedure kit components, and introducing recycling into clinical areas.
- Reducing energy use and transitioning to renewable energy sources in hospitals and clinics.
- Reducing transportation to and from appointments through telehealth.

Telehealth has played an important role in increasing specialty healthcare access and reducing the environmental footprint of transportation to clinic visits. Patients with limited mobility face significant challenges in transporting to appointments, which can be easily addressed through telehealth visits, which dramatically reduce transportation-related greenhouse gas emissions.[50,51] A recent retrospective study of an integrated healthcare system in the US found that telehealth visits were the primary contributor to a greater than 50% reduction in per-appointment carbon intensity during the year 2020.[50] Even before the COVID-19 pandemic accelerated the use of telehealth, there was interest among PM&R providers in using telehealth as a way to increase access to physiatric healthcare services, with 76.8% of SCI providers in a 2019 survey expressing interest in further education on telehealth.[21]

From telehealth to waste reduction to disaster preparedness, robust climate policies will prove essential to protecting the health of people with disabilities.

Research

Current research on the effects of climate change on the patient population in PM&R is limited, and large gaps remain. Filling in these gaps will be critical to meeting patients' needs in the face of a worsening climate crisis.

In 2017, Simard et al.[4] noted that "in much of the available literature on climate change and disaster risk reduction, there remains a prevailing trend that 'vulnerable' people are grouped together. People with disabilities, women, children, older persons and indigenous people are commonly grouped together under the 'vulnerable' banner. People with disabilities themselves are not a homogenous group: individuals with disabilities have immensely varying degrees of resilience to climatic shocks. Specifically, it is clear that whilst the intersections

TABLE 1. Noncomprehensive list of extant resources for healthcare providers and trainees interested in becoming involved in climate and health advocacy or healthcare sustainability

Organization	Climate Focus	Website
Medical Society Consortium on Climate and Health	Climate advocacy for health professionals	https://medsocietiesforclimatehealth.org
Sustain our Abilities	Climate advocacy for health professionals and people with disabilities	https://www.sustainourabilities.org/
Medical Students for a Sustainable Future	Climate advocacy for medical students	https://ms4sf.org
Physicians for Social Responsibility	Climate advocacy for health professionals	https://www.psr.org
My Green Doctor	Environmental sustainability of clinics	https://mygreendoctor.org
Practice Greenhealth	Environmental sustainability of healthcare institutions	https://practicegreenhealth.org
American College of Physicians' Climate Change Toolkit	Educational materials and environmental sustainability of healthcare institutions	http://www.acponline.org/advocacy/advocacy-in-action/climate-change-toolkit
Royal College of General Practitioners' Green Impact for Health	Environmental sustainability of healthcare institutions—United Kingdom based	http://www.greenimpact.org.uk/giforhealth
Health Care without Harm	Environmental sustainability of healthcare institutions with an international focus	https://noharm.org/

Resources include advocacy groups, educational materials, and practical guides to improving healthcare environmental sustainability.

between an impairment and other situations of exclusion, marginalization and risk (including age, gender, location, power) are acknowledged as important, to date there is limited literature that explores – or measures – evidence of how these different layers intersect; nor how this impacts on individual and community resilience and capacities."[4] Clearly, much work needs to be done in addressing these research gaps and in developing and studying effective solutions.

Examples of such research and development gaps include:

- Developing evidence-based best practices for natural disaster preparation and mitigation for people with disabilities.
- Investigating the role of natural disasters on long term health for those with disabilities, including the mental health consequences of these disasters.
- Understanding the complex intersection between people with disabilities and other vulnerable groups.
- Developing evidence-based best practices to prevent EHI, such as optimizing heat acclimatization across regional variations in climate and for people with disabilities.
- Understanding the environmental and health benefits of plant-based diets for people with disabilities.
- Understanding the impact of green space accessibility on rehabilitation clients and professionals.
- Developing best methods for promoting active transportation (i.e., walking, biking) to encourage physical activity.
- Advancing technical innovations, such as solar-powered assistive devices that may function despite power interruptions.
- Researching the safety and feasibility of reusable or biodegradable medical equipment such as catheters.
- Developing carbon-neutral practice environments.

To achieve physiatry's potential to be climate collaborators, leaders, educators, advocates, and researchers, we as a society must invest heavily in these areas. Substantial funding from national, state, and societal organizations will be required. In light of the estimated $800 billion annual cost of climate change on human health in the US, this investment will likely save money and more importantly lives.[15] It is an opportunity for an investment in the future of humanity—one that we cannot afford to waste.

CONCLUSIONS

Physiatrists must be prepared to address the complex health impacts of climate change on our unique patient population and to address the specialty's contribution to this problem through waste and emissions. Robust investment in advocacy, research, and education is required to tackle this complex and worsening problem. Physiatrists' training in supporting an interdisciplinary team and understanding the complex physiological and psychosocial needs of people with disabilities positions us as uniquely able to confront the health effects of climate change for our patients.

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