

# Proposed Mitigation and Adaptation Strategies Related to Climate Change: Guidance for OEM Professionals

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Climate change is an urgent challenge amplified by socioeconomic factors that demands thoughtful public health responses from OEM professionals. This guidance statement from the American College of Occupational and Environmental Medicine focuses on the different strategies that these health professionals can implement to protect workers from health impacts associated with climate change hazards, foster workplace resilience in the face of rapidly changing environments, and take the necessary steps to mitigate the effects of global climate change.

Global climate change is an urgent challenge amplified by socioeconomic factors that demands thoughtful public health responses from occupational and environmental (OEM) professionals. It confronts us in the present moment. Occupational physicians are sentinels for new things and see problems as they arise, often long before others. One such example related to the occupational medicine practice is the clinician working in the Salinas Valley, California, witnessing this evolving existential threat of changing climate,

unfolding at an exponential pace, impacting communities, and directly affecting workers' health and well-being as well as livestock and crops. Global climate change presents immediate, ongoing, and comprehensive challenges to occupational and environmental medicine (OEM) professionals.

In 2018, the American College of Occupational and Environmental Medicine (ACOEM) released a guidance statement to assist OEM in treating and preventing climate-related health problems. OEM responsibilities include developing prevention strategies and plans of action for employers to reduce worker exposures to extreme temperatures, poor air quality, high pollen counts, flooding, and vector-borne disease.<sup>1</sup> This document seeks to update that guidance by offering OEM professionals information on climate change adaptation and mitigation strategies. All health care professionals have a duty to inform stakeholders within their sphere of influence about the drivers and health consequences of climate change. OEM professionals should be familiar with evidence-based strategies aimed at early identification and reduction of health risks precipitated by climate change hazards. In collaboration with unions, employers, climate advocacy groups, non-governmental organizations, and governments, OEM professionals can also contribute to resiliency and sustainability efforts at the worksite.

This ACOEM guidance statement will focus on the different strategies that OEM professionals can implement to protect workers from health impacts associated with climate change hazards, foster workplace resilience in the face of rapidly changing environments, and take the necessary steps to mitigate the effects of global climate change. Note that some efforts may address dual impacts—improved transportation alternatives may reduce adverse cardiopulmonary effects of air pollution (adaptation) while also reducing greenhouse gas-driven climate change (mitigation).

## Learning from the Past

Smoking cessation campaigns provide a successful example of collaborative efforts to improve worker health in the face of major structural challenges. Since 1979, the National Institute for Occupational Safety and Health (NIOSH) has issued current intelligence bulletins (CIBs) on tobacco use,<sup>2</sup> which have evolved from an initial focus on protecting workers from a specific occupational hazard to emphasizing a comprehensive, integrated strategy of advancing the health of workers as embodied by its Total Worker Health<sup>®</sup> program.<sup>3</sup> The late 1990s and early 2000s marked the implementation of comprehensive smoking bans by states prohibiting smoking in most workplaces and all public spaces. Although some workplace smoke-free policies are still not explicitly mandated by state or local governments (CIB 67),<sup>2</sup> employers and unions agree that worksite programs and policies offer many benefits, including decreasing secondhand smoke exposure of non-smoking employees at work, increasing smoking cessation rates, particularly when combined with specific occupational health programs and increasing productivity.<sup>2-7</sup> Smoke-free policies have a broader impact of reducing hospitalizations for heart attacks and asthma in the general population. Similar to the current state of climate change policy, tobacco control policy was a politicized issue throughout the 1990s with executive orders on smoking bans differing by presidential administration.<sup>8</sup> Although climate change is an area of political debate, physicians and health professionals have a duty to protect human health, using the best available science and appropriate health communications tools to discuss climate risks and the benefits of mitigation strategies.<sup>9</sup>

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## STRATEGIES (FRAMEWORK) TO PROTECT WORKERS FROM THE HEALTH IMPACTS OF CLIMATE CHANGE

### Workers, Unions

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change

(IPCC) found an increased frequency of extreme weather events (eg, heat waves, floods, droughts, cyclones, and wildfires) between 2000 and 2010,<sup>10</sup> and workers are the most at risk. Specific jobs, such as outdoor work, can increase a worker's risk of exposure to extreme heat and to heat-related illness. Even moderate heat exposure can result in heat-related fatalities in the presence of factors such as inadequate acclimatization, extreme levels of exertion, and worker age, medications, obesity, or other conditions.<sup>11</sup>

Climate change requires improved educational outreach to workers. For OEM professionals to educate workers effectively, they should be familiar with evidence-based strategies aimed at early identification and reduction of hazards associated with climate change to prevent resulting adverse health effects. For many OEM professionals, the individual worker may be the most relevant focus for educational outreach, while others may have the capacity to address worker advocacy groups, unions, supervisors, and industry leaders. Effective worker education should be participatory, relevant, and meet the expressed needs of the worker audience. When appropriate, the education should be in collaboration with peer educators, from trusted sources of information, in the context of job security, and given the opportunity for workers to have their voices heard.

Recommended worker education topics related to the topic of heat stress include:

- 1) Recognizing and preventing heat-related illnesses, including heat stroke:
  - a. Acclimatization,
  - b. Water, rest, shade,
  - c. Hazardous work conditions,
  - d. Buddy system,
  - e. Individual risk factors,
  - f. First aid training.
- 2) Listening sessions to identify barriers and facilitators for heat injury prevention:
  - a. Identifying solutions for worker's health and safety,
  - b. Creating solutions to reduce drivers of climate change and promote sustainability.
- 3) Education to workers/employers on how climate change is changing atmospheric conditions to have increasingly more intense and prolonged periods of heat stress secondary to rising temperatures.<sup>12</sup>

Trade unions and other labor representatives have become more involved in the climate change movement. For these groups, battling climate change is about creating a better working environment for workers and for society. Thoughtful transitioning to an environmentally sustainable

society can create thousands of new jobs in public transportation, wind and solar energy, and home renovations, creating a sustainable economy. Many labor organizations are gaining insights directly from the members about how the climate crisis is affecting them locally through live meetings and online surveys.<sup>13</sup> This information is used to provide a better understanding to the labor groups on how climate is impacting workers in real-time and what additional measures need to be taken to advance local and national climate action agendas.

#### Case Study 1

Occupational medicine clinicians (including physicians, nurses, and other health personnel) can play a crucial role to engage individual workers and community organizations on climate-related issues. Listening to worker and community perspectives and concerns about climate while engaging as equal partners in participatory educational outreach will help identify facilitators and barriers to prevention. By activating these workers and communities and making them equal partners in participatory educational outreach efforts, significant progress can be made on the climate front. One successful example is the Migrant Clinician Network (MCN), a non-profit organization dedicated to health justice for the mobile poor and the creation of practical solutions at the intersection of poverty, migration, and health. MCN spearheads a number of projects aimed at addressing environmental and work-related health conditions.<sup>14</sup> MCN's Workers and Environmental Health program has collaborated with the Ventanilla de Salud (VDS), health-related outreach centers in Mexican consulates in the US, to develop, implement, and evaluate peer-educator programs in worker safety and health. MCN and Ventanilla de Salud collaborated through an Occupational Safety and Health Administration (OSHA)-funded training grant to develop and implement participatory peer education for occupational safety and health (OSH) topics, including heat illness prevention training. From 2018 to 2019, the program trained 26 community health workers (CHWs) to provide OSH training in settings in Texas, California, and North Carolina, eventually reaching over 800 immigrant Mexican workers. MCN provides information and technical assistance to clinicians and CHWs in safety net community health centers throughout the US and offers continuing education, addressing occupational and environmental health topics. Although clinicians and CHWs express interest in workplace exposures, including heat, as important to their patients, they are overwhelmed with other responsibilities and feel underprepared to provide OSH guidance. These clinicians expressed interest in consulting with trained occupational medicine providers, who can offer important, practical information about heat illness prevention.<sup>15</sup>

## EMPLOYERS

### General Health and Safety Management

Given the pace at which global warming is occurring, it is more important than ever for employers to realize the direct and indirect impacts of climate change on the health and safety of both workers and business as a whole. Employers have a responsibility to evaluate how climate change and its recognized hazards are affecting their workers' health. This evaluation can be conducted in consultation with OEM professionals including health and safety managers.

Both domestic and international corporations must employ a robust OSH management system to successfully integrate and implement climate-sensitive metrics. An OSH management system considers all factors affecting health, safety, and security by considering the health of the individual worker, the work environment, and the larger operating general environment. Considering the workforce as a population, in the context of both work and the general environment, allows OEM professionals to better explore and understand the factors which can affect either an individual worker or a group of workers. This perspective allows for active planning of appropriate mitigation strategies and risk reduction.

The recommended approach in occupational and environmental medicine is to reduce the health effects of toxic and hazardous exposures and follow the standard process of risk assessment and risk management using the hazard hierarchy of controls. This involves implementing methods of risk elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE) at all three levels of OSH management. Personal accommodation and institutional interventions should be considered at workplaces with occupational climate hazards. Utilizing current standards for quantifying exposure limits and particles not otherwise classified or regulated (such as those issued by the American Conference of Governmental Industrial Hygienists) can help in achieving permissible exposure limits. Corporations, including many Fortune 500 companies, utilize the recently promulgated Global Reporting Initiative (GRI) to report on sustainability. By using the GRI report to measure and manage the impacts of climate change on the workforce, OEM professionals can standardize reporting parameters.<sup>16</sup> Using the same standardized process allows for more efficient communication, alignment on intervention, and

monitoring of the implemented interventions between the corporation and the consulting OEM professionals.

OEM professionals can utilize the existing framework found in GRI 403-10 to offer professional expertise to employers on worksite specific climate hazard risks and related occupational health impacts.<sup>16</sup> Section 403-10c of the GRI calls for employers to report all hazards that may cause a risk to worker health. The employer must also list what was used to determine the hazard, which specific hazards caused or contributed to the ill health and what hierarchy of controls were utilized to control or eliminate the hazards. OEM professionals working within companies are well-poised to inform leadership of the positive business case for reducing their carbon impact and increasing sustainability. OEM professionals should be leaders in their organizations when it comes to all occupational health and safety issues, including climate change related risks. They should work in collaboration with representatives of internal stakeholders (senior leadership, HR, facility engineers, security personnel, legal) by creating occupational health and safety committees to assess relevant risks for their workforce, plan preventive/mitigation measures, and monitor and evaluate impact of their interventions. Demonstrating climate leadership is not only beneficial in terms of reducing the company's carbon footprint, but it also emphasizes the importance of these efforts to key stakeholders.<sup>17–20</sup> Understanding employers' perspectives of climate change on operations and profitability can yield important information about how specific industries have been affected and their collective knowledge, attitudes, and beliefs toward efforts to sustain their respective businesses.

OEM professionals have the responsibility to assess workplace risks and counsel employers on preventive and control measures to maintain the health and well-being of their workforce. Such measures provide additional benefits for business continuity and productivity in the face of climate instability and its associated health risks.<sup>1,21</sup> Labor productivity losses due to excess heat are estimated to reach as high as 11% to 20% by 2080 in heat-prone regions like Asia and the Caribbean. This corresponds to billions of dollars of labor productivity and direct health impact losses.<sup>22</sup> Avoiding these health impacts (and limiting global warming to 2°C) can yield economic savings that exceed the US \$1.5 to 2 billion per year outlaid for health sector adaptation and can begin to approach the estimated US \$70 to 100 billion per year of overall adaptation investment needed by 2050.

The Hazard Vulnerability Analysis is a tool used by OEM professionals to assess probability, impact, and preparedness for employer specific risks or hazards.<sup>23</sup> This tool can be used to assess climate risk on any level. Probability is calculated by determining risks, historical data, and predictive data. Severity of the hazard is determined by calculating the hazard's potential impact on the worker population, the business, and the associated infrastructure/property. The preparedness of the organization is determined by its prevention plans, available resources, and partnerships. This useful tool can be found on the internet as a downloadable template that can be adapted to climate risk analysis, the geographic location, and the employer.

Once the risks are stratified, a system to eliminate or control the most probable and the most impactful risks can be implemented. NIOSH recommends the hierarchy of controls: elimination, substitution, engineering controls, administrative controls, and PPE.<sup>24</sup> Elimination of the hazard is the most effective control; PPE is the least effective. If elimination of the climate hazard is not possible, OEM professionals can collaborate to identify appropriate engineering or administrative controls and may determine fitness for duty to work and provide supervisor and worker education on adaptation and resilience. Medical monitoring, another service OEM professionals provide, screens for health impacts on worker populations in at risk environments and provides a feedback loop on the effectiveness of the employer's controls. OEM professionals can also share their expertise with employers to develop prevention efforts, especially for those workers who are most vulnerable.<sup>25</sup>

Workplaces can take the necessary steps to anticipate potential environmental hazards. Employers should: 1) develop emergency preparedness and response plans with a climate-focused lens; 2) address the impact of various environmental hazards on workers; 3) tie in environmental health assessments in workplace inspections; 4) incorporate and implement climate-friendly initiatives system-wide, complete with performance metrics; and 5) set up green spaces across the exterior and interior work environment.<sup>26</sup> Incorporating clean technologies into the workplace (eg, new solutions for industrial wastewater treatments, zero-emission electric buses and trucks, smart thermostats, use of solar panels if feasible, and new energy-efficient devices to capture carbon dioxide from industrial sources, among others) can help employers save money and promote sustainable practices among employees, thus creating a climate-friendly culture.<sup>25,26</sup>

## Disaster Preparedness and Response

Climate-related disasters have caused an estimated US \$14 billion in health-related costs over a 10-year period in the US alone.<sup>27</sup> OEM professionals in all settings are well placed to play a key role in disaster and emergency preparedness based on their clinical skills, understanding of the wider workplace context, and accessibility to the workforce. Such a role is important in all stages of a disaster.

The Sendai Framework for Disaster Risk Reduction (SFDRR) 2015 to 2030 is a global strategy for addressing risk and enhancing resilience adopted at the Third United Nations World Conference on Disaster Risk Reduction in 2015.<sup>28</sup> The sendai framework for disaster risk reduction has 13 guiding principles that are collaborative, voluntary, and non-binding. The primary aim is to address disaster risk factors, strengthen resilience, enhance disaster response, and help "Build Back Better" in recovery stages.<sup>21</sup>

On a national and local level, OEM professionals should have a firm understanding of the National Incident Management Systems (NIMS) and its Incident Command Systems (ICS) which are the standardized approaches to disaster management and emergency preparedness in the US.<sup>29</sup> National incident management systems provides common terminology in preparation for the uniform incident management of a disaster by a variety of organizations performing diverse roles. The ICS provides organizations a standard command, control, and coordinated approach that can be utilized across multiple organizations effectively for incident management.

### Case Study 2

To better understand how heat can impact workers and corporations in Europe, the HEAT-SHIELD project was initiated. This project is a European Union-sponsored consortium of researchers, policymakers, industries, and societal organizations focused on addressing the negative impact of increased workplace heat stress on the health and productivity of workers in the manufacturing, construction, transportation, tourism, and agricultural sectors. The aim of this multidisciplinary effort is to find preventive solutions to protect the health and productivity of workers in the workplace from excessive heat.

To better assess heat-related occupational vulnerability factors requires an understanding of the ethnic demographics of the workplace and the workers who make up that culture, as a risk factor for heat-related human health. In one assessment as part of the HEAT-SHIELD project, native and migrant workers in two agricultural and one construction companies in Italy were asked to complete a questionnaire survey

during the summer months of 2017.<sup>30</sup> The study aim was to investigate how cultural aspects could influence heat stress perception. As compared to the native workers, migrant workers reported that they exerted more physical effort in their work but felt less of the heat impacts. The migrant workers also reported being more productive despite the greater heat stresses. Moreover, the researchers found that the migrant workers were informed about heat and related issues through written/oral bulletins whereas native workers received this information through training sessions. The study did unveil underlying disparities in heat stress perception among migrant workers as compared to native workers. The study authors did provide insights on how health and safety training for migrant workers could be improved and communications enhanced to optimize working conditions in these conditions. Migrant workers declared that work activity required a greater amount of effort but reported less heat-related impact of work as compared to their native Italian counterparts. Moreover, health communication strategies differed among the groups: migrant workers were mainly informed through written or oral communications and native workers received information on heat-health issues through training sessions. Thus, within a workforce, the study authors found that ethnic and cultural backgrounds of workers can impact understanding of extreme heat and response to extreme heat.

## GOVERNMENTS

The role of government is twofold: to provide services (eg, education, infrastructure, security, incentives) and to impose obligations (eg, traffic or environmental regulations, taxes). Mitigating and ultimately reversing global warming, and developing strategies for resilience and adaptation, require major governmental action at all levels—local, regional, and national. However, participation in international agreements, investments in renewable forms of energy, and imposition of regulatory constraints on highly polluting industries have all suffered from climate denial in recent US national policies. State and local governments have implemented programs that may help guide future national efforts.

In the absence of a federal heat illness prevention standard, states can tailor heat standards to the specific working populations and needs of their state. OEM professionals are qualified to assist with the development of such standards. California adopted a heat stress standard (Title 8, Chapter 4 §3395, Heat Illness Prevention) in 2006, which applies to all outdoor places of employment.<sup>31</sup> The standard ensures the provision of potable drinking water and access to shade, outlines high heat and emergency response

procedures, acclimatization rationale, and employee and supervisor training. It also requires a heat illness prevention plan but does not include a heat stress threshold which accounts for humidity and mandatory rest breaks.<sup>32</sup> A 2019 draft standard, Heat Illness Prevention in Indoor Places of Employment, is currently under review.<sup>33</sup>

The Washington State Department of Labor and Industries enacted the Outdoor Heat Exposure Rule in 2008.<sup>34</sup> This rule specifically applies to those performing outdoor work, from May 1 through September 30, if employees are to be exposed to temperatures  $\geq 31.7^{\circ}\text{C}$  ( $89^{\circ}\text{F}$ ); for those wearing double-layer woven clothes (eg, coveralls, jackets, and sweatshirts) in temperatures  $\geq 25^{\circ}\text{C}$  ( $77^{\circ}\text{F}$ ); or those wearing nonbreathing clothes (eg, vapor barrier clothing or PPE such as chemical resistant suits) in temperatures  $\geq 11.1^{\circ}\text{C}$  ( $52^{\circ}\text{F}$ ). The rule notes that the employer's written accident prevention program must include an outdoor heat exposure safety program. Employers must provide training to workers and supervisors before beginning heat-intensive work and the program outlines criteria for provision of water and procedures when employees show signs or symptoms of heat-related illness.

The Minnesota OSHA heat stress standard applies to indoor workers only.<sup>35</sup> It addresses hydration, acclimatization, heat stress monitoring, engineering controls to reduce exposure (eg, improved ventilation, installing local exhaust, proving heat shields, etc), training for supervisors and employees on the hazards of heat stress, recognizing the signs and treatment of heat stress.

Most recently Maryland House Bill 722, passed in 2019, requiring Maryland's state OSHA to develop and adopt regulations on occupational exposure to excessive heat by October 2022. The standards are to include establishing heat stress levels and employer level heat stress prevention programs.<sup>36</sup>

### Case Study 3

At its most basic, the government's response to the rising death toll from heat-related illness in the US should include a clear, enforceable standard for all employers to implement. A review of 359 heat-related deaths that occurred between 2000 and 2010 found higher rates among workers who were male, Hispanic, or African American; in small establishments with 10 or fewer workers; and in southern states.<sup>37</sup> An updated review found that, over the past 20 years, the rate of heat stroke fatalities among all US workers has risen by one-third, despite a flattening or reduction of

other causes of occupational fatalities during that time. Outdoor workers, including construction and agriculture workers, have accounted for most of the increase, disproportionately affecting Latinx and African American men. Certain construction trades, including cement masons and roofers, are at even higher risk.<sup>38</sup> Excessive heat exposure is also associated with increased injury rates and interacts with other worksite exposures associated with occupational health disparities.

Impermeable clothing, respirators, gloves, and other forms of PPE that may be required to reduce pesticide exposure in fields or asbestos exposure in demolition or asbestos abatement, can significantly increase heat stress. Higher ambient temperatures increase solvent evaporation resulting in increased exposure levels and are associated with physiologic changes that increase the potential for enhanced dermal and respiratory absorption of toxic substances. Case series reports of OSHA investigations for heat-related illness found that 79.2% occurred among outdoor workers, 5% occurred at temperatures below those generating any heat index warning, and an additional 20% occurred on days rating only the lowest level of "Caution," highlighting the importance of occupational factors such as exertion and solar load that are not included in population warnings. Fully 45.5% occurred during the worker's first day on the job, while none of the employees offered acclimatization programs.<sup>39,40</sup>

NIOSH has updated its 1986 criteria document addressing occupational exposure to heat, recommending adoption of a standard with specific criteria for prevention.<sup>32</sup> OSHA has failed to propose, much less enact, such a standard. Instead, it initiated a heat illness prevention campaign in 2011 that is ongoing and consists primarily of educational outreach to workers and employers, including resources such as smart phone heat applications and educational materials. OSHA investigations of reported heat-related illness take place under the General Duty Clause of the Occupational Safety and Health Act, which requires employers to maintain a workplace free from recognized hazards likely to cause death or serious physical harm.<sup>41</sup> However, in February 2019, the Occupational Safety and Health Review Commission refused to uphold an OSHA General Duty Clause citation in the death of a roofer from heat stroke.<sup>42</sup> This 60-year-old man with pre-existing health conditions was hired as a temporary laborer by an Ohio roofing company and started work on a hot August day with no acclimatization period. Although he was provided with water and encouraged to rest, neither he nor the crew had any training in heat illness prevention. This ruling demonstrates how severely the absence of a heat-related illness prevention standard limits OSHA's enforcement ability. Such a standard is essential to enable OSHA to conduct inspections to identify hazards and enforce abatement. Municipal ordinances requiring rest breaks are a step in the right direction but fail to address important factors such as acclimatization.

#### Case Study 4

With the recent advent of increasing hurricane frequency and intensity there is an imperative to better prepare populations at risk. Assuming with the growth in only urban population and no environmental change, average global flood losses would increase from about US \$6 billion per year in 2005 to US \$52 billion by 2050. Factoring in climate change and subsidence would increase such losses to US \$1 trillion or more per year. Category 4 Hurricane Harvey made landfall near Rockport, Texas, causing widespread damage with pronounced devastation due to the large region of extreme rainfall, producing historic flooding across Houston and surrounding areas which displaced more than 30,000 people and damaged or destroyed over 200,000 homes and businesses. The cost was estimated to be \$131.3 billion.

How the underserved working communities were affected by these storms and trying to identify the best way to keep individuals healthy during recovery are essential for learning to cope with future occurrences. The aftermath of a flooding event is associated with numerous health problems, particularly involving the respiratory system. Following Hurricane Harvey, the Southwest Center for Occupational and Environmental Health (SWCOEH) at the University of Texas Health Science Center at Houston School of Public Health initiated disaster response activities, including an outreach program to provide local residents and workers with PPE and training to work safely on remediation activities in the aftermath of the storm's devastation. Such efforts should be incorporated into the governmental response to such disasters.

## FUTURE WORK AND GOALS

### Policymaking and Global Strategies

To address the climate emergency, comprehensive strategies need to trigger long-term systemic shifts to change the trajectory of greenhouse gas levels entering the atmosphere. Governments around the world have spent considerable time and effort in recent years to develop plans to chart a safer and more sustainable future for their citizens. Coordinated federal policy efforts are required, aimed at energy, transportation, agriculture, in addition to environmental and occupational regulations. International successes and failures in addressing the COVID-19 pandemic offer stark lessons.

An example of a regional policy to improve the environment for communities and workers is the Regional Greenhouse Gas Initiative (RGGI).<sup>43</sup> Regional greenhouse gas initiative is the first multi-state, market-based program designed to reduce emissions of carbon dioxide (CO<sub>2</sub>) in the electric power sector. Since its

implementation, the participating states have witnessed economic benefits, reductions of emissions as well as health savings due to lowering of air pollutants.

Policies to protect workers from the health impacts of climate change can include collaborative efforts to develop green transition in the form of a decarbonized economy, green sustainable jobs, and investment in sustainable solutions. OEM professionals who know their legislators and create trusting relationships with them as the expert voice in health and climate serve the best interests of the public as well as the profession. In turn, policy making can truly benefit from seeking out the health perspective in all policies.

### Research

Research to reduce the occupational health impacts of climate change is urgently needed and requires a thorough gap analysis. Basic science as well as applied research efforts are needed to identify approaches to reduce the greenhouse gas contribution from construction, where cement production accounts for 6% of all CO<sub>2</sub>, as well as in the food cycle, to reduce climate drivers ranging from deforestation to landfill food waste. Important etiologic research is still necessary to identify specific modifiable risk factors and the populations at risk for emerging problems, such as chronic kidney disease of unknown etiology as well as for long-standing questions about pregnancy outcomes. Intervention effectiveness research for a variety of engineering and administrative controls as well as for innovative PPE is needed, along with participatory action research to engage workers and learn from frontline experience. Good research drives progress. It has a huge impact on the direction, strategies, resources, and motivations of a given occupational provider for developing strategies and requires funding and prioritization. Dissemination research is needed as well as outreach to local, state, and national governments to ensure they apply information that is technically accurate. Organizational research to inform effective programs and methods needs to help put innovations into practice.

### Collaboration

Occupational safety and health is an inherently interdisciplinary field. To incorporate environmental sustainability, adaptation, and mitigation into workplace settings will require additional collaboration.<sup>44</sup> This type of collaboration goes beyond the traditional inclusion of industrial hygienists in determining the most appropriate, comfortable, and effective PPE. For example, collaboration may include technical institutes that incorporate

climate-related education into their skills-based curriculum to prepare the future workforce or local environmental organizations to promote sustainability in food or transportation choices. On the global level, the work practices of organizations that operate across countries will certainly benefit from consultant collaborators to adapt and create resiliency programs. Public health professionals and OEM professionals should collaborate to identify and address cross-cutting climate-related health threats. OEM professionals working within state government agencies are uniquely situated to initiate data and resource sharing among labor and public health agencies. Existing public health surveillance systems may be adapted to maximize the collection and use of health data relevant to the working population. Public health surveillance may capture climate-related health effects in a way that workers' compensation claims data cannot. Collaborative efforts dually inform prevention-focused interventions and can also support advocacy for policy changes to address the "double burden" workers face with both community and workplace exposures to air pollution, extreme heat, and other climate-related hazards.<sup>45</sup>

## CONCLUSIONS

Industrialization has driven global climate change; lives and livelihoods now depend on achieving resiliency and attending to sustainability. As the IPCC makes clear, we need to act now and focus on short-term goals that may achieve long-term benefits. Fortunately, what helps the transition to a healthier environment can also help with provision of a healthier workplace. OEM professionals can contribute to achieving more sustainable practices because they are integral to attaining occupational safety and health goals. Climate change effects have already caused enormous harm and are expected to worsen in the future.

New strategies and efforts to protect workers and promote workplace resilience and sustainability are urgently needed. OEM professionals are positioned to pursue policymaking, research and collaborative interventions with workers, unions, employers, and governmental organizations to effect change now and in the future.

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