

Impacts of Climate Change on Workers' Health and Safety FREE

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Summary

Climate change has increased the risk to workers' health and safety. Workers, especially those who work outdoors or in hot indoor environments, are at increased risk of heat stress and other heat-related disorders, occupational injuries, and reduced productivity at work. A variety of approaches have been developed to measure and assess workers' occupational heat exposure and the risk of heat-related disorders. In addition, increased ambient temperature may increase workers' exposure to hazardous chemicals and the adverse effects of chemicals on their health. Global warming will influence the distribution of weeds, insect pests, and pathogens, and will introduce new pests, all of which could change the types and amounts of pesticides used, thereby affecting the health of agricultural workers and others. Increased ambient temperatures may contribute to chronic kidney disease of unknown etiology among workers. Global warming is increasing ground-level ozone concentrations with adverse effects on outdoor workers and others. Extreme weather events related to climate change pose injury risks to rescue and recovery workers. Reducing the risks of work-related illnesses and injuries from climate change requires a three-pronged approach: (1) mitigating the production of greenhouse gases, the primary cause of climate change; (2) implementing adaptation measures to address the overall consequences of climate change; and (3) implementing improved measures for occupational health and safety.

Keywords: climate change, worker, global warming, heat, risk, outdoor, illness, injury, pesticide, weather

Subjects: Environmental Health, Global Health, Special Populations

Introduction

Climate change is expected to produce unprecedented shifts in the environment, ecology, economics, and population health, and presents new challenges to the protection of workers from on-the-job hazards (Adam-Poupert et al., 2013; Applebaum et al., 2016; Levy & Patz, 2015b; Roelofs & Wegman, 2014; Schulte et al., 2016). These challenges are arising as workers throughout the world are suffering from increasing socioeconomic inequality and precariousness of work (Julià, Vanroelen, Bosmans, Van Aerden, & Benach, 2017).

Workers in many occupational and industrial categories already experience climate- and weather-related hazards in their jobs. The increasing frequency, duration, and severity of extreme weather events and other developments caused by climate change will exacerbate these hazards and affect a broad range of workers. Increased temperature, extremes of precipitation,

increased air pollution, the spread of vector-borne disease, and other health threats due to climate change will impact many groups of workers. Because of financial pressures and work requirements, many workers may not be able to avoid these threats.

Socioeconomic disruptions and ecological changes caused by climate change will affect workers in many ways. Work hours, locations, conditions, opportunities, and security will change for many workers as economic sectors adjust to higher temperature, extremes of precipitation, and rising sea level. These disruptions and changes will adversely affect the health and well-being of many workers and decrease their productivity, most notably in agriculture and construction. Communities adversely impacted by sea-level rise or the decline in employment based on fossil fuels may experience more poverty and worse health status. Employment in some high-hazard industries, such as fishing, may decrease and employment in other industries, such as renewable energy, energy conservation, and coastal protection, will likely increase. Extreme weather events and adaptation to minimize damage will likely increase jobs in construction, utility, and tree work—all of which currently have high injury rates (Ochsner, Marshall, & Lefkowitz, 2018). However, preventive measures can reduce the risk of these health effects (Marinucci, Luber, Uejio, Saha, & Hess, 2014).

Many work-related hazards due to climate change are already well-characterized, such as injuries in workers fighting wildfires or clearing debris from hurricanes, heat-related illnesses in farmworkers, and Lyme disease in outdoor recreation workers. However, climate change will likely expand the number and types of workers exposed to these and other hazards including pesticides used to control vectors (Moore, Qualls, Brennan, Yang, & Caban-Martinez, 2017).

Climate-related threats can cause injuries and illnesses in many population groups, but workers are at greater risk because their livelihoods often depend on their exposure to these threats. For example, while nearby residents move away from wildfires, firefighters don heavy protective gear and move toward wildfires. While the general public heeds heat-related warnings, outdoor workers labor in the heat. Workers face not only their work-related exposures but also community challenges that most other people face, such as power outages that shut down home air conditioners and mental stress from extreme weather events. In low- and middle-income countries, these community challenges also include malnutrition due to food insecurity, distress due to forced displacement, and collective violence due to socioeconomic or political instability (Levy & Patz, 2015b; Luber & Lemery, 2015).

Workers with less economic or social power are more vulnerable to the impacts of climate change. The Intergovernmental Panel on Climate Change (2014) stated: “Differences in vulnerability and exposure arise from non-climatic factors and from multidimensional inequalities. . . . These differences shape differential risks from climate change. . . . People who are socially, economically, culturally, politically, institutionally, or otherwise marginalized are especially vulnerable to climate change” (p. 6).

Workers often lack protective policies and practices that would allow them to stop work and thereby avoid a hazard. The piece-rate system for agricultural workers, based on the amount of a crop each worker harvests, creates disincentives for them to take breaks to rest, hydrate, and

move into cooler areas. Chronic dehydration in workers performing heavy work in the heat may cause or contribute to the epidemic of chronic kidney disease of unknown etiology (Roncal-Jimenez, García-Trabanino, Wesseling, & Johnson, 2016).

Dependency on employment forces many workers to stay in jobs that endanger their health. The effects of this dependency may be exacerbated by other factors, such as discrimination on the basis of race/ethnicity, immigration status, or gender and socioeconomic vulnerability from inadequate education, limited fluency in English, or minimal job skills (Levy & Patz, 2015a). “Climate refugees” displaced from their home communities due to climate disruption may have to migrate to other countries and then take precarious and risky jobs in agriculture and construction. Improved socioeconomic policies and better preparedness of employers can minimize these problems.

Specific Work-Related Hazards of Climate Change

In addition to global threats, scientists can often predict region-specific threats, such as increased frequency, duration, and severity of extreme weather events (such as heat waves, worse air pollution, and changing geographic patterns of vector-borne diseases) (US Global Change Research Program, 2016). The US National Institute for Occupational Safety and Health (NIOSH) has described how these changes are likely to affect workers' exposure to hazards (Schulte et al., 2016; Schulte & Chun, 2009). Specific types of workers expected to be especially impacted include most outdoor workers (especially those in construction, agriculture, and tourism), emergency-response and recovery workers, and workers in the fishing-and-forestry and utility-delivery-and-transportation sectors.

Even small to moderate increases in ambient temperature at work can cause discomfort, especially if workers are wearing personal protective equipment, and can increase exposure to hazardous chemicals (Balbus, Boxall, Fenske, McKone, & Zeise, 2013). Several categories of workers who work indoors may also be impacted, especially those who work in warm spaces that are not air-conditioned, such as bakeries, warehouses, and foundries. Preventive measures include changing hours of work and increasing investment in renewable energy, although these measures may introduce new hazards (World Health Organization, 2014).

Extreme Heat

Increasing frequency, duration, and intensity of periods of extreme heat heighten the risks of heat-related morbidity and mortality (Smith et al., 2016; Xiang, Bi, Pisaniello, & Hansen, 2014). In addition to outdoor laborers, such as farm, utility, delivery, and construction workers, others who work in environments where there usually is no air conditioning, such as warehouses and railyards, are at increased risk (Gubernot, Anderson, & Hunting, 2014). In general, workers with few or no rest periods and with limited access to water and cool spaces are at an especially high risk (Kjellstrom, Freyberg, Lemke, Otto, & Briggs, 2018).

Acute health effects of exposure to extreme heat include heat exhaustion, heat rash (prickly heat), heat syncope, dehydration, heat stroke, and complications of many chronic diseases, including chronic obstructive pulmonary disease, coronary artery disease, diabetes mellitus, and chronic kidney disease. Chronic health effects due to continued heat exposure also include mental health problems such as anxiety, depression, and suicide; chronic kidney disease, possibly due to recurrent dehydration and other factors; and congenital malformations of the heart and brain in infants of women who worked during early pregnancy in physically demanding jobs. In addition to the direct effects of heat on workers' health, heat may also increase risk of injury, as shown in a study in Thailand (Tawatsupa, 2013) and a study of Deepwater Horizon oil spill clean-up workers (Garzon-Villalba et al., 2016).

Increased ambient temperature due to climate change may cause or contribute to chronic kidney disease of unknown etiology among agricultural workers in tropical areas (Moyce et al., 2017; Nerbass et al., 2017; Roncal-Jimenez et al., 2016; Tawatsupa et al., 2012; Wesseling et al., 2013). From 1993 through 2013 in Mexico and Central America, increased temperature and working conditions with resultant dehydration may have caused deaths related to chronic kidney disease in approximately 20,000 agricultural workers (Roncal-Jimenez et al., 2016).

In some areas in the Middle East and elsewhere, human life may not be sustainable in the near future. In 2015, in the Iranian port city of Bandar Mahshahr, the heat index (which incorporates absolute temperature and humidity) reached 165°F (75°C), based on an outdoor air temperature of 115°F (45°C), which has a dew point temperature of 90°F (32°C) (Samenow, 2015). Agricultural workers in tropical parts of Southeast Asia are expected to be markedly impacted because of high daytime temperatures and agricultural work shifts will likely be shortened dramatically (Kjellstrom et al., 2018). Since heat tolerance and adaptation are generally relative to anticipated heat (Spector & Sheffield, 2014), even in nontropical areas adverse effects of outdoor heat on workers will likely occur more frequently as summers become warmer (Adam-Poupart et al., 2014).

Increased ambient temperature due to climate change may also increase occupational exposure to hazardous chemicals and their adverse effects on workers (Balbus et al., 2013). Climate change will likely increase exposure to many environmental pollutants, such as by increased volatilization due to warmer temperature, which can result in airborne transport of chemicals for long distances (Bourbonnais et al., 2013). In addition, increased temperature and higher moisture content in the atmosphere may increase the environmental persistence of some chemicals.

Wildfires

Climate change is increasing the frequency and severity of wildfires. As a result, the frequency and severity of resultant occupational health and safety hazards, such as falling trees and heat exhaustion, and the numbers of fatal and nonfatal injuries among firefighters and other responders are increasing (Britton et al., 2013; Withen, 2015). Firefighters also suffer burns, smoke inhalation, transportation-related injuries, and cardiac arrest (Adetona et al., 2016; Britton et al., 2013). Smoke inhalation from fires, in addition to excessive heat, is a potential hazard for other workers (Shaposhnikov et al., 2014).

Extreme Weather Events

Many workers are at high risk of occupational hazards from extreme weather events such as hurricanes, which will likely increase in frequency and severity with climate change. Extreme weather events pose a variety of health and safety hazards to rescue and recovery workers, such as injuries from slips and falls and from being struck by airborne objects, inadequate sleep and nutrition because of long and uninterrupted work shifts, physical exhaustion, mental stress, and vehicular crashes (Leon, Hyre, Ompad, Desalvo, & Muntaner, 2007). Floods, landslides, lightning strikes, and wildfires pose serious hazards. Heavy snowstorms can cause roof collapses and related hazards for workers ("Worker dies," 2015).

Following an extreme weather event, rescue and recovery workers may be exposed to toxic substances, asbestos and other hazardous dusts, and mold. Clean-up workers after Hurricane Katrina, which hit New Orleans and the surrounding Gulf Coast region in 2005, developed "Katrina cough" from exposure to airborne particles and microbial agents (Noe et al., 2007; Rando, Lefante, Freyder, & Jones, 2012). Following Hurricane Sandy, which hit the New York–New Jersey coast in 2012, tree and landscaping workers suffered from increased injury rates (Ochsner et al., 2018).

Extreme weather events may also undermine safety controls. An example of this problem occurred at the Arkema Chemical plant in Crosby, Texas, following Hurricane Harvey in 2017. Numerous plant workers, first responders, and community residents were adversely affected by a series of chemical explosions at the plant, which resulted from flood waters cutting power to refrigeration units there (Newkirk, 2017).

Worker safety may be compromised after extreme weather events if newly recruited recovery workers are not adequately trained or if safety regulations are not enforced (Campbell, 2017). After three major hurricanes in the fall of 2017, the US Occupational Safety and Health Administration suspended enforcement of safety regulations for more than a month in hurricane-affected areas in Texas, Florida, and Puerto Rico (Gonzalez, 2017).

Air Pollution

Warmer temperatures will likely cause more air pollution, especially with ground-level ozone and fine particulate matter (Bell et al., 2007; Fiore, Naik, & Leibensperger, 2015; US Global Change Research Program, 2016). In addition to wildfires, droughts (with associated wind-blown soil and dust) will contribute to air pollution. Increased pollen production and longer pollen seasons are causing more allergic disorders among workers and others. Workers most likely to be impacted by increased air pollution include outdoor workers in urban environments, firefighters, drivers, and workers in indoor spaces without filtered air.

Biological Hazards and Pesticides

In the United States, many workers are already at risk of tick-borne illnesses such as Lyme disease (Schulte et al., 2016). Climate change is broadening the range of disease vectors (such as ticks and mosquitoes), thereby increasing disease risks of outdoor workers in the construction, utility, recreation, agriculture, forestry, landscaping, and natural-resource-management sectors (Moore et al., 2017). As the incidence of vector-borne diseases rises, there will likely be greater application of pesticides accompanied by increasing pesticide exposure to agricultural workers, landscapers, and pest control workers (Boxall et al., 2010; Gatto, Cabella, & Gherardi, 2016).

Psychological Stress and Productivity Losses

Extreme weather events may increase stress on workers, especially rescue and recovery workers and healthcare workers (Brooks, Dunn, Amlôt, Greenberg, & Rubin, 2016; Leon et al., 2007). Extreme heat will likely reduce worker productivity and increase stress, such as changing work hours, thereby causing conflicts between workers and employers and between workers and their family members (Kjellstrom, 2016; Marchetti, Capone, & Freda, 2016; Sahu, Sett, & Kjellstrom, 2013).

What Needs to Be Done

Multiple strategies will be required to reduce the risks of work-related illnesses and injuries from climate change. Employer and worker preparedness includes recognizing, anticipating, and controlling potential occupational safety and health hazards resulting from both climate change and from implementation of mitigation and adaptation measures to address climate change. For example, policies to mitigate and adapt to climate change may lead to changes in infrastructure and energy use that may positively or negatively impact workers' health and safety. Occupational health surveillance will need to be broadened to include the health and safety impacts of climate change on workers.

A holistic approach to addressing potential impacts of climate change on workers' health and safety involves coordinated and integrated hazard recognition and response (Roelofs, 2018). The Building Resilience Against Climate Effects (BRACE; Figure 1) framework of the Centers for Disease Control and Prevention, which includes vulnerability assessment followed by preparatory action and evaluation, can be adapted to help reduce occupational health and safety hazards and make work environments safer (Marinucci et al., 2014) (Figure 1).

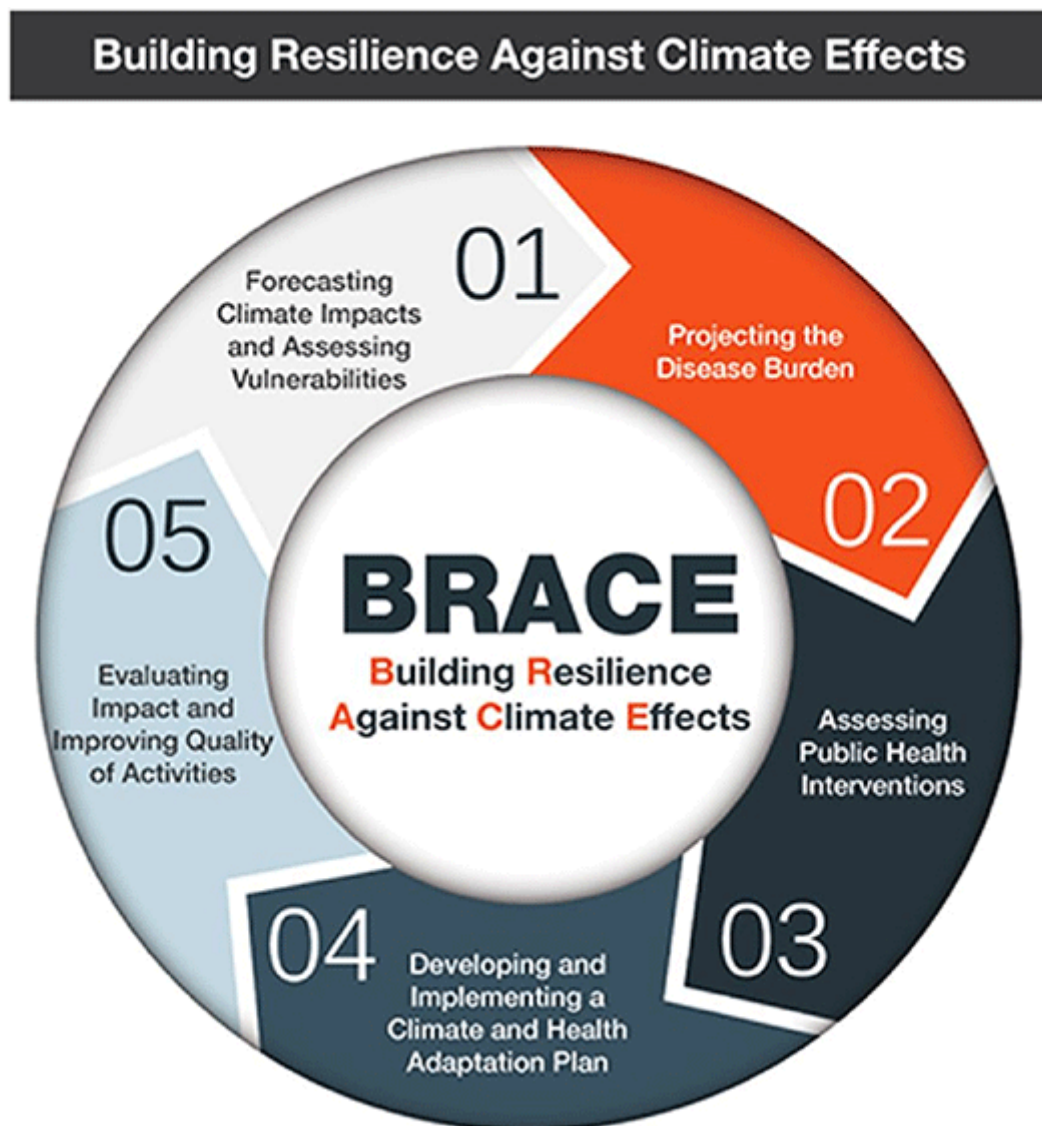


Figure 1. The Building Resilience Against Climate Effects (BRACE) Framework of the Centers for Disease Control and Prevention.)

(Source: Centers for Disease Control and Prevention. CDC's Building Resilience Against Climate Effects (BRACE) Framework <<https://www.cdc.gov/climateandhealth/BRACE.htm>>.

Workplace Strategies

Health and safety management practices, including management commitment and employee participation in hazard recognition, assessment, and control, should address new and increased hazards resulting from climate change. The adaptive management approach promoted by the BRACE framework can help employers and workers adapt to the new normal. Employer preparedness includes:

- devoting resources to hazard recognition;
- performing vulnerability assessments to determine which workers are vulnerable to climate change-related hazards (and when, how, and why);

- implementing a control strategy with policies, procedures, equipment, and work organization that eliminates or minimizes the impact of these hazards.

Employer preparedness may involve dramatic changes in work operations, scheduling, and building safety. It may also involve integration and interaction with other types of preparedness, such as establishing communication links to reach workers at home or involving fire departments in process safety management (Occupational Safety and Health Administration [OSHA], 2018). The Emergency Responder Health Monitoring and Surveillance framework of NIOSH provides recommendations to protect emergency responders in any setting. It can facilitate integration of worker health monitoring into incident command structures and can guide long-term monitoring of potential health effects resulting from emergency-response exposures (National Institute for Occupational Safety and Health [NIOSH], 2018).

Beyond emergencies, employers need to recognize worker health and safety hazards and integrate occupational health and safety into long-term planning. Detailed guidance for employers already exists for some recognized hazards faced by workers, such as extreme heat (Jacklitsch et al., 2016). However, this guidance may need to be adapted for climate change-related hazards that vary and are unpredictable (Bethel, Spector, & Krenz, 2017). In addition, new training will be required to create worker awareness of new or more intense hazards due to climate change and to inform employers on how work may need to be modified to address these hazards (Chan, Yi, Wong, Yam, & Chan, 2012; Nag, Dutta, & Nag, 2013; Riley, Delp, Cornelio, & Jacobs, 2012; Singh, Hanna, & Kjellstrom, 2013). In the United States, federal agencies are improving worker training for disaster response and clean-up workers (National Clearinghouse for Worker Safety and Health Training, 2015; OSHA, 2018). Nevertheless, employers are responsible for providing training and equipment to protect workers (Delp, Podolsky, & Aguilar, 2009). New technologies and equipment, including sensors and climate-adapted personal protective equipment, are being developed to improve protection of workers facing threats due to climate change (Chan et al., 2016).

Prevention Through Design

Prevention-through-design strategies can be implemented to embed worker health and safety into building a more resilient infrastructure and energy-efficient buildings. For example, renewable energy facilities, such as wind-turbine farms, can be designed to prevent injuries to maintenance workers. In addition, standards for office buildings that previously focused on energy use can be revised to comply with ventilation and other requirements for workers (NIOSH, 2018).

Research

Occupational safety and health research should be expanded. It should include (a) investigating climate change-related hazards and at-risk populations; (b) using surveillance data on diseases, injuries, and occupational hazards to guide research agendas; and (c) developing, implementing, and evaluating new adaptation measures (Adam-Poupart et al., 2013; Schulte & Chun, 2009).

Surveillance

Public health surveillance is the “ongoing, systematic collection, analysis, and interpretation of health data, essential to the planning, implementation, and evaluation of public health practice, closely integrated with the dissemination of these data to those who need to know ” (National Academies of Sciences, Engineering, and Medicine, 2018, p. 21). Surveillance can be used to identify the impact of climate change on worker health; to help establish research agendas; and to help plan, implement, and evaluate preventive measures. Data from “sentinel events” due to climate change can be analyzed so that lessons can be learned to prevent similar problems in the future (Pierce, 2017).

Current public health surveillance systems that depend upon employers' reports to government agencies are not sufficient to detect the impacts of climate change on workers' health (Harduar Morano et al., 2017). New approaches will be needed. For example, data from emergency departments may be necessary for surveillance of worker injuries due to extreme weather events, such as storms and heat waves (Harduar Morano et al., 2015; Ochsner et al., 2018). In the United States, the Council of State and Territorial Epidemiologists is addressing this need by developing climate-change indicators that could obtain data related to occupational health and safety problems (English et al., 2009; Harduar Morano et al., 2017).

Occupational Medicine and Clinical Response

Clinicians have important roles to play in recognizing, diagnosing, treating, and preventing workers' adverse health effects caused by climate change (Patz, Frumkin, Holloway, Vimont, & Haines, 2014). Clinicians should educate themselves and their colleagues about these adverse health effects, especially those that are temporally and geographically relevant to their communities. They should also educate their patients who are at high risk for specific disorders due to climate change, such as older people and outdoor workers who are at increased risk of heat-related disorders and patients with chronic respiratory disorders who are more frequently exposed to hazardous levels of air pollutants. Public health surveillance systems depend on clinicians' diagnoses and their cooperation in sharing data with health departments. In addition to their roles in advising their patients to take individual preventive measures, clinicians can play important roles in supporting policies to mitigate the production of greenhouse gases and supporting programs to help communities adapt to the consequences of climate change, such as increased frequency of heat waves, wildfires, and extreme weather events.

Workplace Standards and Policies

Regulations and guidelines for the prevention of climate change-related occupational hazards, such as extreme heat, will need to be developed and implemented (Parsons, 2013). Safety regulations for hazards caused by extreme weather events may need to be applied to more workers and work situations. Regulations and guidelines to encourage employer preparedness will need to be improved (Bruce, 2012; Lucchini et al., 2017).

Conclusion

As a result of increased risks of work-related illnesses and injuries due to climate change, measures are required to improve the recognition and prevention of occupational illnesses and injuries. Clinicians, public health workers, and others need to be trained to improve their skills in suspecting and accurately diagnosing climate-related medical conditions in workers, especially heat-related disorders, and helping to prevent these disorders.

Prevention of work-related illnesses and injuries includes designing and implementing measures directed at the workplace, such as reducing physical labor during peak heat, making air conditioning available wherever feasible, and scheduling necessary rest periods during work shifts. It also includes designing and implementing measures directed at workers, such as providing adequate information and training to prevent heat-related disorders, making lightweight workclothes available, and ensuring adequate hydration.

Climate change exacerbates existing occupational health and safety problems and creates new ones. It presents many challenges for which new and improved approaches are necessary.

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