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Worker health and safety and climate change in the Americas: issues and research needs

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SYNOPSIS

This report summarizes and discusses current knowledge on the impact that climate change can have on occupational safety and health (OSH), with a particular focus on the Americas. Worker safety and health issues are presented on topics related to specific stressors (e.g., temperature extremes), climate associated impacts (e.g., ice melt in the Arctic), and a health condition associated with climate change (chronic kidney disease of non-traditional etiology). The article discusses research needs, including hazards, surveillance, and risk assessment activities to better characterize and understand how OSH may be associated with climate change events. Also discussed are the actions that OSH professionals can take to ensure worker health and safety in the face of climate change.

Keywords: Climate change; occupational risks; occupational exposure; working environment; Central America; Americas.

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Global climate change, which has become one of the most visible environmental concerns of the 21st Century, can impact human health both directly and indirectly (1). As with any rapidly evolving issue, the transition from a theoretical possibility to a recognized threat presents broad challenges, from risk assessment to preparedness planning (2). Although there is considerable research and planning on the effects of climate change on public health and the environment (3), this paper will focus specifically on its implications for worker health and the safety.

Workers are often the first to be exposed to the effects of climate change, for longer durations and at greater intensities than the general public. Additionally, workers are often exposed to conditions that the general public can elect to avoid. Furthermore, the number of employee working in the most affected occupations is likely to increase. Given as much, workers could be called "the canaries in the coal mine" of climate change; that is, adverse impacts on workers, such as disease or injury, may be among the first indicators of its health effects (4). The challenge is to characterize how these climate events may influence worker health and safety and to establish plans for mitigating, responding, and adapting to the current and anticipated impacts.

Worker populations affected by climate change include agricultural workers, construction workers, emergency responders, commercial fishermen, paramedics and fire fighters, transportation workers, and other workers exposed to outdoor weather conditions, particularly those performing physically demanding work for extended periods of time, e.g., sugarcane cutters (5, 6). Indoor workers can also be affected by climate change; for example, increased heat and air pollution exposure among factory workers. some workers—migrant workers, informal workers, and day-laborers—may be more vulnerable to the health effects of climate change. Extreme poverty may also adversely impact access to healthy sustenance. For these groups, the health effects of climate change that lead to occupational exposure may be exacerbated by onerous non-work-related issues, such as inadequate housing and lack of air conditioning. It is possible that the health burden related to climate change may be greater for workers in low- and middle- income countries in tropical areas or areas with frequent exposure to extreme weather events and high temperatures; these same countries could have fewer resources available for mitigation and adaptation (7, 8). Moreover, in less developed areas, risk-response may be less organized than in developed ones that typically have comprehensive regulations and emergency response systems.

There are a number of ways to characterize the impact of climate change on workers. In general, it can

be approached from three different perspectives: (i) amplification of known safety and health hazards, such as severe weather events, heat, wildland fire, infectious disease, and air pollution; (ii) new, unanticipated, or unrecognized hazards, such as widening infectious disease vector ranges, rise in pesticide use, and increases in aeroallergens; and (iii) hazards that result from the human response to climate change, such as the development of renewable energy, recycling, carbon sequestration, "green industries," and changes in how structures and communities are built and maintained (9–11).

Potential health consequences to workers who may be affected by a changing climate include: asthma, respiratory allergies, and airway diseases; cancer; cardiovascular disease and stroke; heat-related morbidity and mortality; chronic kidney diseases of non-traditional origin; mental health and stress-related disorders; neurological diseases and disorders; water-borne diseases; weather-related morbidity and mortality; and vector-borne, zoonotic, and other infectious diseases, such as Lyme disease, Valley Fever (coccidioidomycosis), chikungunya, malaria, and dengue (12–23).

Although increased heat exposure related to climate change can affect health by a number of mechanisms, research on its impact on chronic non-communicable diseases is lacking (24). Table 1 depicts the known and expected climate change associated hazards, by industry sector or worker demographic. Exposures and risks are potentially aggravated by social and economic factors, such as precarious working and poor living conditions.

CLIMATE CHANGE AFFECTING WORKERS

Extreme temperatures

Temperatures are increasing around the globe, exacerbating the existing heat burden of tropical areas and beyond, for indoor as well as outdoor work environments (3). Higher temperatures or longer, more frequent periods of heat may result in greater occupational heat stress, potentially leading to more cases of heat-related illnesses (e.g., heat stroke, heat exhaustion), decreased chemical tolerance, and fatigue (15 – 17). Exposure to increased temperature can also result in reduced cognitive function and increased risk of injury or lapses in safety (25, 26). In addition, heat can be a contributing factor to many other severe or fatal injuries or illnesses, such as those caused by falls or myocardial infarctions. With a warming climate and more frequent extreme weather events predicted, heat exposure and heat stress are becoming a prominent employee safety issue. Even small changes in average temperature can potentially translate into a substantial increase in the number of deaths and cases of severe heat or cold-related illness. Yet, there are few regulatory standards in place to protect workers from climate change-related hazards (4).

Outdoor workers. Those affected by climate change include agricultural workers, construction workers, emergency responders, commercial fishermen, paramedics and fire fighters, transportation workers, and other workers exposed to outdoor weather conditions.

TABLE 1. Overview of known and anticipated climate change-related worker safety and health hazards, 2016

Sector	Climate change factor(s)	Potential hazards/health issues
Agriculture	- Increased heat and solar radiation exposure. - Increased risk of flooding, erosion of air quality.	- Heat related illness. - Increased vector borne diseases, both new and existing (e.g., lyme disease, chikungunya). - Increased pesticide use to combat expanded range of pests and plant diseases. - Potential impact on access to potable water and sanitation. - Exposure to air contaminants.
Construction and emerging industries	- Temperature extremes. - Erosion of air quality. - Modifications to building design and new materials in response to climate change. - Increase in recycling, carbon sequestration, and unanticipated climate-related industries	- Increased heat and exposure to air contaminants (outdoor and indoor). - New building materials and construction practices with unanticipated safety and health hazards and exposures, or exacerbation of existing hazards.
Emergency response	- Increased frequency and intensity of extreme weather events, landslides, floods, prolonged dry periods, increased rainfall in shorter periods. - Increased frequency and magnitude of wildfires wildland fires, floods, erosion of air quality.	- Access to potable water/sanitation. - Exposure to air contaminants - Mental stress. - Increased exposure to safety hazards associated with responding to emergencies. - Increased exposure to vector borne diseases. - Increased exposure to heat, cold, and solar radiation.
Renewable energy	- Construction of wind farms, solar energy, hydroelectric. - Possibly increased reliance on nuclear power	- New/unanticipated safety hazards associated with wind farm, solar energy, and hydroelectric installation and maintenance. - Chemical hazards from manufacturing of wind towers and solar panels, from wind farms and solar energy construction. - Ionizing radiation and other (safety, chemical) hazards related to nuclear energy.

Source: Prepared by the authors from the study data.

Increased temperatures are particularly onerous for outdoor workers who perform physically demanding work for extended periods. In many of these occupations, the need to wear protective clothing can exacerbate heat stress (27).

Indoor workers. While outdoor workers with strenuous workloads are clearly vulnerable to climate change, indoor and semi-indoor workers may also be affected by increased outdoor temperatures and humidity, specific industrial operations, building systems, and work requirements. High heat exposures are likely in indoor environments with poor ventilation and no cooling systems, and in factories with heat-generating processes (26, 28). For example, a study in India found that heat index measurements were higher in a cookie factory and canteen than in construction and agricultural work sites (29). As in some outdoor work environments, some indoor workers wear protective clothing that can result in increased heat stress.

Air pollution

Air pollution—linked to acute and chronic health effects, such as ischemic heart disease, stroke, respiratory diseases and allergic disorders (30)—has a complex relationship with climate change. For example, elevated temperatures can increase levels of air pollution, e.g., ground-level ozone and wildfire smoke. Since 1986, the combination of earlier snowmelt due to warmer springs (resulting in a longer fire season), and warmer summers (resulting in lower soil moisture) have been the major contributors to increased fire activity (31). Wildfire smoke contains particulate matter, carbon monoxide, nitrogen oxides, and various volatile organic compounds and can significantly reduce air quality in urban and rural areas alike, both locally and downwind of fires (32, 33). Whether indoor or outdoor, workers may be increasingly exposed to air pollutants as a result of climate change, though the presence and magnitude of such effects depend on local conditions.

Extreme weather events

Because extreme weather events and natural disasters—floods, landslides, storms, lightning, and droughts—are becoming more frequent and intense, the need for emergency responders is increasing (34). Workers involved in rescue and cleanup therefore will have more frequent exposures to the risky conditions created by weather disasters (14).

Extreme weather events may also cause damage to infrastructure (power lines, roads, and transportation) and buildings. Workers could be put in new or unfamiliar circumstances leading to a high risk of traumatic injury, diseases, and mental stress (35, 36). Some workers may be at increased risk of violence if mobility, electricity, communication, food, and shelter become compromised. These events can lead to increased risk of traumatic injury.

Wildland fires

The risk of wildfire is strongly linked with climate, and climate change is projected to substantially increase wildfire activity (37). According to the United States National Interagency Fire Center, 9 of the 10 years with the largest acreage burned have occurred since 2000 (38). This period coincides with many of the warmest years on record. And there is a positive feedback loop: climate change influences fire, and fire activity can influence climate. The increase in wildfires and extended fire season will require response from more and more firefighters, including volunteers. Common hazards faced by wildland firefighters can include burns, heat-related illnesses, smoke inhalation, and injuries from slips, trips, and falls. In addition, due to prolonged intense physical exertion, wildland firefighters are at risk for rhabdomyolysis, a condition resulting from an increase in core body temperature and the subsequent breakdown of muscle cells and release into the bloodstream (39).

Vector-borne diseases and other biological hazards

Changing temperatures and shifting rainfalls can affect the habitats of vectors, pathogens, hosts, and allergens. Increased prevalence and distribution of water-borne and food-borne pathogens can affect outdoor, emergency response, and health care workers. Pollen may increase from earlier flowering and longer pollen seasons (12). Increasing numbers of hurricanes and floods could lead to more houses with mold, and greater exposure among remediation and construction workers (40). Increasing temperatures and atmospheric carbon dioxide may increase the growth and spread of poison ivy and other poisonous plants (23). Temperature changes affect insect vectors, increasing their populations, extending their transmission seasons and expanding their distribution seasonally and spatially (41). Therefore, outdoor workers may be at increased risk for mosquito-borne diseases, such as West Nile, dengue, chikungunya, malaria, and Zika; and tick-borne diseases, such as Lyme disease (42). Previous research has found that outdoor workers were 5 times more likely to acquire Lyme disease than indoor workers (43). Vector ranges are expected to continue to expand, and diseases may be introduced into new areas. Because of the anticipated rise in rate, range, and duration of the growth periods for pests and weeds, pesticide use is expected to increase (44). Moreover, the potential for acquired resistance to current products, even in areas where specific pesticides were not previously used, means potentially increasing exposure among pesticide applicators and other workers (45, 46).

Ice melt in the Arctic

The Arctic is rapidly changing, in tandem with the climate. As a result, the need for workers in the Arctic is expected to increase (47). Arctic communities are already experiencing the effects of climate change on

lifestyle and health (48), and specific assessments of the effects on occupational health and safety are needed here (49). One dramatic and undeniable change is the loss of sea-ice covering the Arctic Ocean and its peripheral seas. This changing environment is also allowing for a potential increase in oil and gas exploration, mining, shipping, commercial fishing, tourism, and associated support services. As the expansion of high-risk industries in extremely remote arctic locations continues, emergency response times, search and rescue resources, and the provision of adequate protections for oil-spill or other environmental contamination response workers may emerge as significant concerns (50).

Chronic diseases

There are possibly several chronic diseases that can be exacerbated or even attributed to the effects of climate change. A strong case is the epidemic of Chronic Kidney Disease of non-traditional etiology (CKDnT), which has been linked to increased temperatures in lowland areas of Central America (51). CKDnT is responsible for the death of thousands of workers in Central America (51, 52), with the highest, age-standardized mortality rates in 2008 among men in El Salvador and Nicaragua (approximately 65 per 100 000 individuals) (53). Sugar cane cutters have the highest risk of CKDnT, probably due to performing strenuous work in extreme heat with insufficient hydration and possible exposure to pesticides. Several studies have identified heat stress and dehydration as potentially important determinants of CKDnT (54, 55). In Costa Rica, regulations to protect workers from heat stress and dehydration were ordered by a Presidential decree in July 2015 (56). It is hoped that other countries in Central America will follow Costa Rica's lead. Other factors that may influence the progression of climate change, and in turn affect its impact on workers, are population growth, energy policies, increasing urbanization, drought, and deforestation. It is likely that the variety of occupations and number of workers that may be affected will increase.

RESEARCH AND ACTION POLICIES

Future research should examine the interactions between climate change and workers, identify vulnerable worker populations, ascertain appropriate surveillance and indicators, develop risk communication tools, and investigate the effectiveness of controls. Addressing these research needs may lead to improved awareness of the consequences of climate change for worker health. Research may also provide evidence-based information for the mitigation of climate change hazards; for example, developing effective controls and adaptation strategies that reduce climate change impact on workers, reinforcing vigilance to identify and control unanticipated hazards, creating new work practices, and using alternative chemicals and materials.

Research is needed to characterize the hazards to workers from the direct effects of severe weather events, heat, wildland fire, and infectious diseases. A better understanding of the occupational health and safety issues that result from the human response to climate change—renewable energy, carbon capture and sequestration, material substitution, and changes to indoor air quality from new building and infrastructure designs—would also be helpful.

Training is an area where action can be taken now to address climate change related worker health and safety issues. Occupational safety and health or other public health professionals can assess training needs and develop training programs or add a climate change component to an existing safety and health training course. They can also develop risk assessments, risk management programs and control recommendations for the at-risk populations, and include climate change in risk communication.

Conclusions

There is strong evidence that climate change is and will continue to present increased risk of occupational injury, disease, and death. Numerous research questions need to be answered regarding specific hazards, sentinel events, risk assessment, and preventive actions. Climate change amplifies existing occupational hazards and exposures; unanticipated hazards may emerge. Workers are often the first to be exposed to the effects of climate change and are affected for longer durations and at greater intensities than the general public; adverse events among workers may be the first indicators of how a changing climate is affecting health (4).

Through research, knowledge of the effects of climate change on worker health can improve the effectiveness of prevention strategies. A systematic research approach can provide a better understanding of the impact and the actions necessary to comprehensively anticipate, recognize, communicate, and control these hazards and mitigate their health effects.

Finally, building resilience among the workforce will require raising awareness among the economic sectors affected (e.g., agriculture, construction, hospitality, emergency preparedness, and the health care sector), developing preventive interventions, and designing and implementing adaptation plans. Affected sectors must anticipate and be prepared to respond quickly and effectively to protect workers' lives from the disasters caused by climate change. A multi-sectorial approach and broad stakeholder participation are necessary to ensure that working men and women will be involved in the mitigation efforts.

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RESUMEN

Salud y seguridad laboral y cambio climático en las Américas: temas clave y necesidades de investigación

En este informe se resume y analiza el conocimiento actual sobre el impacto que el cambio climático puede tener sobre la seguridad y la salud laboral, en particular en la Región de las Américas. Se presentan temas clave de salud y seguridad de los trabajadores relacionados con factores de estrés específicos (por ej., temperaturas extremas), impactos asociados al clima (por ej., derretimiento de hielo en el Ártico) y una enfermedad asociada con el cambio climático (enfermedad renal crónica de etiología no tradicional). En el artículo se analizan las necesidades de investigación, incluso los peligros, la vigilancia y las actividades de evaluación de riesgo a fin de caracterizar y comprender mejor cómo la seguridad y la salud laboral se asocial con los sucesos del cambio climático. También se analizan las acciones que pueden emprender los profesionales de este campo para garantizar la salud y la seguridad de los trabajadores ante el cambio climático.

Palabras clave: Cambio climático; riesgos laborales; exposición profesional; ambiente de trabajo; América Central; Américas.

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