ADVERSE EFFECTS OF CLIMATE CHANGE ON OCCUPATIONAL HEALTH AND SAFETY

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ABSTRACT

The impact of climate change on workers' health is affected by factors, such as population growth, energy policies, and increasing urbanization and deforestation. These factors along with climate change may lead to an increase in the magnitude and severity of known hazards and result in increasing numbers of workers who would be exposed to them. The hazards can be considered in seven categories: increased ambient temperature air pollution; ultraviolet (UV) radiation; extreme weather; expanded vector habitats; industrial transitions and emerging industries; and changes in the built environment. Exposures to these hazards can then lead to various health effects. The potential links between global climate change and occupational safety and health is derived by the World Health Organization (WHO) A review of the literature published between 2005 and 2016 for assessing the relationship between environmental health and policy actions or interventions. This knowledge review highlighted five categories of hazards that could potentially have direct or indirect impacts. In response to the impact of climate change, adjustments in occupational safety and health research and practice could include alteration of standards, modification of hazard controls, development of acclimatization procedures, new research directions, development of new hazard control guidance and hazard communications, development of early warning systems and surveillance, and increased emphasis on prevention through design.

INTRODUCTION

The effects of climate change (CC) are often discussed in terms of its impacts on the environment and the general population. To date, the scientific community has focused very little on its repercussions on occupational health and safety (OHS), yet workers can be affected both directly and indirectly by CC, notably by changes in the ecosystems that form the basis of their economic activities. The potential links between

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global climate change and occupational safety and health can be visualized in a conceptual model shown in Figure 1. It is derived from two models used by the World Health Organization (WHO) for assessing the relationship between environmental health and policy actions or interventions. The impact of climate change on workers' health is affected by other contextual factors, such as population growth, energy policies, and increasing urbanization and deforestation. These factors along with climate change may lead to an increase in the magnitude and severity of known hazards and result in increasing numbers of workers who would be exposed to them. The hazards can be considered in seven categories: (1) increased ambient temperature; (2) air pollution; (3) ultraviolet (UV) radiation; (4) extreme weather; (5) expanded vector habitats; (6) industrial transitions and emerging industries; and (7) changes in the built environment. Exposures to these hazards can then lead to various health effects.

OBJECTIVE

The objective of this review was to explore research topics relating to the negative impact of climate change (CC) on occupational health and safety (OHS) as well as some strategies for protecting workers.

METHODOLOGY

First, a review of the literature published between 2005 and 2016 was performed to identify the main links between CC and OHS. This knowledge review highlighted five categories of hazards that could potentially have direct or indirect impacts on OHS are: heat waves, air pollutants, ultraviolet radiation, extreme weather events, and communicable vector-borne and zoonotic diseases. Another five conditions that could lead to changes in the work environment and have negative impacts on OHS were also identified: changes in agricultural and animal husbandry methods, changes in the fishing industry, disturbances of the forest ecosystem, degradation of the built environment, and the emergence of new "green" industries. Topics were in turn categorized according to three major research orientations: the acquisition of knowledge on hazards and target populations,

epidemiological surveillance, and the development of adaptation measures.

Problems

(Paul A. Schulte and HeeKyoung Chun, (2009))To date, most of the climate change research has focused on the health of the general population rather than on occupational health and safety outcomes. Because of the lack of appropriate health, climate, and other relevant data, it has been difficult to assess how climate change has affected workers.To begin to address complexities, it may be useful to develop a framework for identifying how climate change could affect the workplace, workers, and occupational morbidity and mortality. (NIOSH Safety and Health Topic, Hazards to Outdoor Workers.(2006)The basis for the framework was a review of published peer reviewed scientific literature from 1988–2008. The review focuses on the climate-related health effects, host factors that might enhance susceptibility to climate effects, and the impact of this information on occupational safety and health research and practice. Papers reviewed included those on epidemiologic studies of climate change and health outcomes during 1988– 2008. Literature was included if the study had directly pertinent information on workers. Workers are exposed to many types of hazards that depend on their type of work, geographic region, season, and duration of work time.

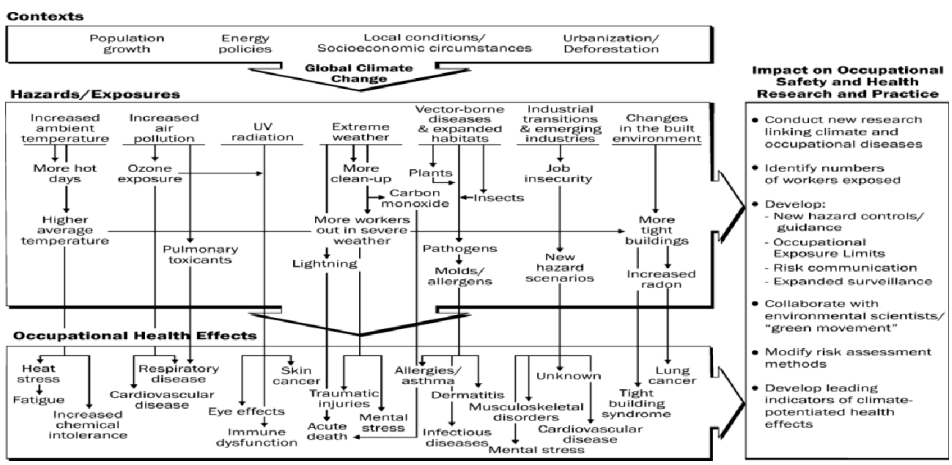

Figure 1. Conceptual framework of the relationship between climate change and occupational safety and health

(Herrera R, Orantes CM, Almaguer M, Alfonso P, Bayarre HD, Leiva IM et al. (2014) &Wimalawansa SJ.(2009)Bennet C &McMichael T.(2016)Any occupational health hazard that is associated with climate factors can naturally also be linked to climate change. Table 1 summarizes the most likely hazards and their effects in vulnerable groups, based on a recent review of a large number of epidemiological and laboratory studies. The most predictable impact of climate change is an increase in environmental heat levels, because the modelling of future climate starts from the influence of greenhouse gases on air temperature. Health effects, such as heat exhaustion, heat stroke, chronic kidney disease and chemical poisoning (Table 1), are therefore part of the occupational health impacts occurring in countries of the WHO South-East Asia Region. Thus, countries or areas with very long periods of hot weather are at particular risk for the heat effects. All of the tropical countries of the region are in this category. The risks of kidney disease and chemical poisoning will depend on other factors at the workplace, but the local heat levels are a key feature. Extreme weather, particularly strong storms or heavy rainfall, can create serious injury and drowning hazards (see Table 1) and emergency workers are a vulnerable group, as the frequency and strength of extreme weather events is likely to increase with climate change.

Table 1. Climate-related occupational health hazards, vulnerable groups and health effects

Climate hazard	**Vulnerable groups**	**Health effects**
High heat exposure (temperature	Workers carrying out physically demanding tasks; outdoor workers	Heat exhaustion, heat stroke
and humidity)	exposed to direct sun	
	Workers in heat-stress situations who do not hydrate enough	Chronic kidney disease
	Workers exposed to highly evaporative chemicals, e.g. organic	Chemical poisoning
	solvents; high heat leads to higher workplace chemical exposures	

Extreme weather, wind	Outdoor workers in affected areas; emergency workers; all workers	Injuries, drowning
	when their workplaces are closed due to weather	
Ecological conditions indirectly	Outdoor workers, particularly farmers needing to work at dawn and	Vector-borne diseases, diseases
related to climate	dusk	related to ecological change
Other indirect climate-related	Low-income groups with limited health protection; workers with existing	Infectious diseases,
hazards	non-climate health problems affected by heat	noncommunica ble diseases,
		mental health issues, etc.

Kjellstrom et al., 2013 and 2016

The other health effects mentioned in Table 1 (vector-borne diseases, infectious diseases, noncommunicable diseases and mental health issues) are indirectly linked to climate change via factors such as ecological conditions, local food-production possibilities, worsened clinical status and displacement from home locations. Climate change involves effects on access to water and water quality, as well as changes in the ecology that may bring disease vectors to new locations. Local changes in climate conditions may be so extreme that continued habitation becomes difficult.

Increased Ambient Temperature

(Parsons K. (2014) ; Ebi KL, Smith JB, Burton Iet al. (2005)High heat exposure creates a risk of heat exhaustion and heat stroke and is subjectively perceived as unpleasant or dangerous People working or involved in heavy physical activity are particularly affected, because physical activity produces additional intra-body heat that must be dissipated. A working person's natural reaction to heat is to reduce physical activity, which reduces the body's internal heat production.

This may be called “self-pacing” or “autonomous adaptation”. An outcome of this preventive reaction is reduced hourly work capacity and reduced economic productivity during exposure to heat.

(Technical Manual (OTM). OSHA Directive TED 01-00-015.(2008;Levy, B.S., and D.H. Wegman (2000)Excessive exposure to a hot work environment can bring about heat-induced disorders, such as dehydration, heat rash, heat cramps, heat exhaustion, heat fatigue, heat syncope/fainting, and heatstroke. Work-related factors such as work practices, work/rest cycles, access to water, and access to shade/cooling and other controls can also affect the development of heat-induced disorders. Factors that could affect susceptibility to temperature-related occupational hazards include age; weight; degree of physical fitness; degree of acclimatization; metabolism; use of alcohol or drugs; a variety of medical conditions such as hypertension or thyroid disease; prior heat injury; and the type of clothing worn. In general, heat-induced occupational illnesses, injuries, and reduced productivity occur in situations in which the total heat load exceeds the capacities of the body to maintain normal body functions without excessive strain.

(Paul A. Schulte and HeeKyoung Chun 2009) Both outdoor and indoor workers are at risk of heatstroke and heat fatigue. The outdoor occupations are most at risk of heatstroke which include construction; refining; surface mining; hazardous waste site activities (e.g., those workers required to wear semipermeable or impermeable protective clothing; personal protective equipment [PPE] such as Tyvek suits, gloves, and half-face, powered air-purifying respirators); agriculture; forestry; and fishing. There also are possible heat implications for indoor workers in such workplaces as greenhouses, glass or rubber manufacturing plants, and for others who work in buildings without air conditioning or proper ventilation systems.

(Levy, B.S. and D.H. Wegman (2000) and (Mirabelli, M.C. and D.B. Richardson2005)Some of the heatstroke deaths reported have been associated with occupational exposure at construction sites, agricultural settings, and hot industrial jobs requiring heavy work leading to increasing the worker’s heat load by generating more metabolic heat.

Individuals in thermally stressful occupations or with pre-existing illnesses (e.g., cardiovascular disease or chronic respiratory diseases) are vulnerable to heat stress; those unaccustomed to the heat are particularly susceptible. Individuals in thermally stressful occupations or with pre-existing illnesses (e.g., cardiovascular disease or chronic respiratory diseases) are vulnerable to heat stress; those unaccustomed to the heat are particularly susceptible.

(WHO South-East Asia Journal, of Public Health 2017) Using the type of calculations presented for India, the potential annual loss of work hours was calculated for five countries in the region (Table□2) and for a number of other countries outside this region.45 These data represent the modelling results for the policies of the Paris Agreement (similar to RCP□6.0)25 and the situation for moderate-intensity work (300□W). Losses as high as 5–9% may have major impacts on the annual economic outputs from local enterprises and could reduce a country's gross domestic product in a significant manner. Such analysis for the countries in South-East Asia is lacking.

Table 2.Potential percentage of annual daylight work hours lost due to environmental heat levels for moderate work (300 W) in the shadea

	Population,		Daylight work hours lost (%)			
Country	**millionsb**	**1981–2010**	**2011–2040**	**2041–2070**	**2071–2099**	
Bangladesh	161	1.1	2.5	4.6	8.6	
India	1311	2.0	3.6	5.2	8.0	
Indonesia	258	0.33	1.2	2.6	5.5	
Maldives	0.4	0.42	1.9	4.5	9.2	
Nepal	29	0.61	1.3	2.0	3.4	

Source: World Health Organization Global Health Observatory data repository.

RECOMMENDATIONS

Occupational safety and health practitioners will need to participate in decisions to recommend environmentally safer materials. The next step in developing the framework is to assess the relative magnitude and frequency of climate-related hazards and the number of workers exposed. This probably needs to be done on a regional basis, with

attention to what industries or occupations might be most affected. Ultimately, there may be the need for a research and prevention agenda as well as a prioritization scheme.It's imperative that employers, safety professionals and workers stay informed about emerging issues and hazards associated with climate change as a way to address worker safety and health.

Some strategies for protecting workers include:

a. Putting formal monitoring systems in place to limit worker exposures by altering workday schedules and/or increasing frequency and length of breaks.
b. Enhancing personal protective gear, as needed, and finding alternative for heat-inducing protective body gear.
c. Tracking changes in occupational exposures and patterns of injury and illness as they pertain to climate change.
d. Reinforcing protective practices with small, sensor-based technology that can pre-warn workers about exposures.
e. Training workers to identify climate-related exposures that can cause hazards.

In response to the impact of climate change, adjustments in occupational safety and health research and practice could include alteration of standards, modification of hazard controls, development of acclimatization procedures, new research directions, development of new hazard control guidance and hazard communications, development of early warning systems and surveillance, and increased emphasis on prevention through design. Standards for hazards that might be increasing as a result of climate change may need to be reviewed to determine if they are still adequate or need to be modified to reflect more frequent exposures.

(Ichihara, G., J.K. Miller, A. Ziolkokwska, S. Itohara, and Y. Takeuchiet al 2007) & (,Majersik, J.J., E.M. Caravati, J.D. Steffens et al 2007)Risk assessment methods may need to be adapted to address a mix of risks not usually considered in occupational standards (e.g., exposure to ticks, poison ivy, mosquitoes, and water-borne diseases). One area of growing concern is that transition to more environmentally safe products or chemicals, i.e., "green" materials as a means to mitigate climate change may be misinterpreted in terms of their safety for workers. For example,

recent neurologic cases involving 1-bromopropane illustrated that what is considered environmentally safe is not necessarily worker safe. Occupational safety and health practitioners will need to participate in decisions to recommend environmentally safer materials. The next step in developing the framework is to assess the relative magnitude and frequency of climate-related hazards and the number of workers exposed. This probably needs to be done on a regional basis, with attention to what industries or occupations might be most affected. Ultimately, there may be the need for a research and prevention agenda as well as a prioritization scheme.

CONCLUSION

Over the next few decades, the global CC context will likely necessitate significant changes in a number of industries and occupations. Substantial challenges will have to be faced as numerous emerging problems will in all probability impact on the work environment. Each problem will have to be examined taking often conflicting environmental, social, and economic constraints into account. Keeping this in mind and in light of the study results, further studies are warranted with respect to the three main priority orientations: the acquisition of knowledge on hazards and target populations, epidemiological surveillance in collaboration with public health partners, and the development of adaptation measures. Standards for hazards that might be increasing as a result of climate change may need to be reviewed to determine if they are still adequate or need to be modified to reflect more frequent exposures.

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