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IMPACT OF CLIMATE CHANGE ON OCCUPATIONAL HEALTH AND ITS POSSIBLE PREVENTIVE STRATEGIES (REVIEW ARTICLE)

By

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Abstract

Introduction: Climate change and other types of environmental alteration are of our generation's most pressing issues. Due to its geographical location and reliance on climate-sensitive economic sectors, Egypt is particularly vulnerable to climate change. Occupational exposure as a result of rising temperatures and climate change has become a threat to the health and safety, productivity, and social well-being of the world's diverse workforce. Both outdoor and indoor employees are expected to be affected by climate change. Heatstroke, headache, exhaustion, insomnia, heart, kidney, respiratory, and skin disorders, immunological dysfunction, infections, injuries, cancer, and (in severe situations) mortality are among the most common occupational health concerns. High temperature, ozone, polycyclic aromatic hydrocarbons, and other chemicals are among the occupational exposures that are predicted to rise due to climate change. Climate change has also been linked to an increase in the spread of pathogenic microbes, vector-borne infectious agents, and wildfires, as well as increased workplace violence. **Aim of Work:** To discuss the different types of occupational exposure that are anticipated to cause climate change, to highlight the regions that would be the most vulnerable to their consequences, and to draw attention to the different preventive measures which are needed to safeguard employees from the health risks of climate change. **Conclusion:** Climate change could raise the risk of work-related diseases and injuries, necessitating steps to enhance the detection and prevention of its impact on occupational health. Employers, governments, and politicians must implement a variety of methods to safeguard employees against the long-term health effects of climate change. Workers should also be informed of any actions that may be taken to mitigate the health effects of climate change.

Keywords: Climate change; Health impacts; Occupational exposures; Possible preventive strategies.

Introduction

Climate change and other types of environmental alteration are of our generation's most pressing issues. Climate change risks might be exacerbated by interactions between hazards, vulnerability, and exposure of human beings, possessions, and environments, according to a study by the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2014). Continuing changes in the physical and bio-geochemical habitat may have an impact on variables such as sea level, sea currents, temperature, and wave action. The potential increase in the frequency and intensity of severe weather (which is any destructive weather, such as intense thunderstorms, tornadoes, blizzard (heavy snow) or flood) could alter the ecosystem services and, as a result, the well-being of people who rely on them. Many countries across the world might be affected by the threat of climate change in all areas of development (UNFCCC, 2009).

The health impacts of climate change on workers

Occupational exposure associated with rising temperatures and climate change has become a concern to the health and safety, productivity, and social well-being of the world's diversified workforce. As a result, the 2030 Sustainable Development Goals (SDGs) are focused on ensuring healthy lifestyles, promoting well-being, ensuring decent employment and work capacity, and combating the effects of climate change on all sectors of development (Leal et al., 2018).

Human health, particularly mental health, is at risk due of climate change, as is access to clean air, safe drinking water, nutritional food, and shelter. Climate change affects everyone at some time in his or her lives. Because of characteristics like as where they live, their age, health, income, and employment, and how they go about their daily lives, some individuals are more affected by climate change than others (Schweitzer et al., 2018).

Egypt is especially vulnerable to climate change, according to IPCC studies in 2014, due to its geographic location and reliance on climate-sensitive economic sectors. A rise in sea level might have a significant impact on millions of people, particularly in the Nile Delta and southeast, exposing these communities to economic, social, and/or health concerns. Climate change has also been cited as a factor in Egypt's precipitation, with some models

predicting yearly drops of up to 5.2 % by 2030, 7.6 % by 2050, and 13.2 % by 2100 (Barbi, 2014 and Kassem et al., 2019).

Workers in poor nations are among the most vulnerable to the effects of climate change, since they are the least able to afford the repercussions owing to underlying social, political, environmental, and economic factors. Furthermore, these circumstances are already causing major health issues in these economies' communities. Many individuals in these economies live in inadequate housing, and the majority of employees perform physically demanding, pay-by-output occupations with little or limited insurance and job options (Nerbass et al., 2017).

Certain groups of employees are more sensitive to the health effects of climate change because of their location and the nature of the work that they do. Climate change has the potential to enhance the frequency and severity of certain current occupational hazards, as well as introduce new and unforeseen dangers. Outdoor workers are frequently among the first to be affected by climate change. Increased temperature, bad air quality, extreme weather (highest or lowest value of a climate element observed during a given period), infections spread by ticks and mosquitoes, industrial exposures, and infrastructure damage are all expected to impair the health of outdoor workers due to climate change. Farmers, ranchers, and other agricultural workers, commercial fisherman, construction workers, paramedics, firemen, police, transportation employees, and other first responders are all affected by climate change (Nunfam et al., 2018).

Climate change has an impact on more than just outdoor jobs. Individuals who work in hot indoor work places (such as steel mills, dry cleaners, manufacturing plants, warehouses, and other spaces without air conditioning) are also vulnerable to climate change consequences such as excessive heat exposure or indoor air pollution. Aside from these, there are various more variables that form risk factors (individual, institutional, and environmental factors) that enhance employees' vulnerability to climate-related occupational risks (Habibi et al., 2021).

The commonest occupational health hazards identified comprise heatstroke, cardiovascular events, fatigability, insomnia, skin dryness and rash, excessive sweating, exhaustion, headache, chemical poisoning, zoonotic infections, injuries, respiratory

challenges, immune dysfunction, nasal bleeding, fainting, bronchial asthma, digestive problems, renal diseases, cancer, and in extreme cases, death (Sadiq et al., 2019). Furthermore, some researchers found female subjects to be infertile, while others found maternal and child health difficulties as a possible outcome of climate change: low birth weight, congenital abnormalities, preterm and post-term deliveries, spontaneous abortion, nutritional problems, and infectious illnesses among female workers were all documented as negative pregnancy outcomes (Rahimi et al., 2020).

Suicidal thoughts, depression, anxiety, impaired brain function, psychological discomfort, and increased violation were all documented among employees exposed to extremely hot temperatures as a result of climate change (Kjellstrom et al., 2017).

While vulnerability to the effects of climate change on the environment has acquired more academic focus in the recent years, susceptibility among employees has gotten less attention. The current review looks at the available empirical information to discuss the different types of occupational exposure that are anticipated to cause climate change, to highlight the regions that would be the most vulnerable to their consequences, and to draw attention to the different preventive measures which are needed to safeguard employees from the health risks of climate change.

As a result of climate change, the following occupational exposures are anticipated to increase:

Temperature Effects

Extreme temperatures have physiological health consequences since they can push the body's core temperature beyond of its healthy boundaries. High temperatures can cause sunstroke, syncope, cramps, tiredness, and lethargy, as well as acute cardiovascular and respiratory failure, by increasing heart and respiratory rates, lowering blood pressure, and damaging internal organs. High temperature has the potential to increase injury rates, as exhaustion is typically a significant factor in injuries. Cold temperature causes arteries and veins to constrict, blood to be viscid, and the body to lose heat, resulting in energy depletion. Frostbite and hypothermia are two primary consequences of frigid weather. Cold temperature may induce muscular strains and sprains, as well as other injuries, since they force muscles to contract and impede blood flow. Ice can develop at temperatures

below 32 degrees Fahrenheit (0 °C), thus increasing the risk of falls or car accidents (Scott et al., 2016).

However, temperature has a direct impact on health. A number of experimental investigations suggest that people's ability to perform various activities is reduced at both high and low temperatures. This loss in performance appears to occur for a number of activities, including psychomotor, perceptual, and cognitive skills, and it has the potential to raise injury rates (Hancock et al., 2007).

Heat, which is expected to grow over time and pose dangers to both outdoor and indoor employees, may be the largest risk posed by climate change to workers (Adam-Poupart et al., 2013).

Work sites where these circumstances are usually encountered include; ferrous and nonferrous foundries, brick-firing sites and ceramic factories, glass industry, rubber plants, electrical industries, bakeries, confectioneries, commercial kitchens, laundries, food canneries, chemical plants, mining sites, smelters, and steam tunnels. Lack of or inadequate air conditioning, as well as limited access to proper ventilation, may increase the risk of heat-related illnesses among indoor workers. Farm labour, construction, oil and gas well operations, asbestos removal, landscaping, emergency response operations, and hazardous waste site activities are among the outdoor occupations most susceptible to heat-related diseases. However, heat-related occupational mortalities and morbidities are not always recognized, and consequently, occupational heat-related diseases are under-reported (Applebaum et al., 2016).

Agricultural labourers are particularly susceptible to heat-related illnesses. Because the task typically demands intense physical activity in an outdoor area with high temperatures and humidity, they are exposed to the acute health impacts of heat, which can range from cramps to life-threatening diseases like heatstroke. Climate change-related temperature rises will raise the burden of heat-related diseases and mortality among agricultural workers if physical effort remains constant (Gubernot et al., 2014).

Heat may have a role in the development of chronic illnesses among employees. Repeated exposure to heat-related events, for example, is assumed to be the cause of an increased prevalence of chronic renal illness, as well as mental, skin, and respiratory disorders in Central America (Adam-Poupart et al., 2013).

Table (1) Heat stress effects on work in terms of the Sustainable Development Goals (Adapted from UNDP, 2016).

Goal	Focus	Impact of rising heat in the workplace
1		The lowest-income groups, in particular agricultural workers, small-scale and subsistence farmers, and casual workers in urban areas in tropical and sub-tropical developing countries are worst affected. Social protection systems in these countries tend to provide only limited coverage.
2		A reduction in the available working hours, and by implication also in outputs, among small-scale and subsistence farmers is likely to affect household food security.
3		Large-scale exposure to heat injury and health risks such as heatstroke, exhaustion and even death will thwart efforts to improve health, particularly in countries without universal health-care coverage. Migrants may be especially vulnerable to health risks if they do not have access to health care and occupational safety and health services in their destination country.
4		Heat-exposed students and teachers are less likely to receive and provide quality education and learning.
5		Many heat-exposed occupational functions involve women and men differently, especially in developing countries. Pregnancy adds to the risks of heat exposure.
8		New heat extremes affect working conditions, productivity and economic growth. They make it more difficult to comply with international standards and guidelines on the occupational safety and health of workers. The economic consequences are considerable.
10		High-income temperate regions are affected by heat stress to a far lesser extent than tropical and subtropical developing regions, which counteracts efforts to reduce inequalities.
11		Heat extremes pose a challenge to the built environment (houses and workplaces) and its sustainability. Significantly, heatwaves are more intense in urban areas.
13		The impact of climate change on labour is a major challenge to climate resilience that has yet to be effectively recognized or addressed through international and national measures.

Ozone

Temperatures are expected to degrade air quality, ozone being particularly affected. Changes in air pollution processes such as ventilation, precipitation, and increases in human and natural sources are predictable to worsen air quality.

Ozone has both acute and chronic effects on human health. The induction of respiratory symptoms such as cough, wheezes, sore throat, and shortness of breath, as well as eye irritation and asthmatic episodes, are all short-term effects. Chronic exposure to high ozone levels has been linked to an increased risk of death from respiratory disorders such pneumonia and chronic obstructive pulmonary disease (COPD). With more time spent outside and higher ventilation rates due to increased physical activity, outdoor workers are at greater risk of exposure to higher levels of ozone than the general population. Thus, climate change is anticipated to raise the risk of respiratory consequences for outdoor workers beyond the existing state (Jerrett et al., 2009).

At levels below the occupational permissible limits (OSHA, 100 ppb PEL; ACGIH, 50–100 ppb TLV for heavy to light workloads, respectively), both acute and chronic effects occur in healthy persons. Only a few studies have looked at the effects of ozone exposure on outdoor workers, especially impaired lung function and DNA damage at concentrations lower than 75 parts per billion (Tovalin et al., 2006).

Furthermore, epidemiological research showed that heat stress increases the toxicity of airborne contaminants such as ozone and particulate matter (Gordon et al., 2011).

Agriculture, construction, fishing, forestry, mining, oil and gas extraction, transportation, and landscaping are among the occupational sectors at danger from rising ozone levels as a result of climate change. Future ozone concentration changes will be regionally different, with the greatest increases anticipated to occur in cities with existing high concentrations.

Polycyclic Aromatic Hydrocarbons (PAHs)

They are molecules made up of two to seven fused benzene rings that are generated through the combustion of carbon-containing materials like coke, petroleum-based fuels, and biomass materials like crops and forests. PAHs include hundreds of chemicals that differ in their volatility from very volatile to non-volatile.

PAHs are widely believed to be

mutagenic and carcinogenic. Traffic cops, tunnel construction workers, garage employees, drivers (particularly those who keep the vehicle windows down), and wildland firefighters are among those who operate in close proximity to combustion sources and are exposed to high levels of PAHs. Only a few studies focused on occupations with significant PAH exposures, such as foundry, asphalt, and coke oven workers, have indicated health effects related with PAH exposures. Increased exposure is linked to an increased risk of cancer and coronary heart disease (Bosetti et al., 2005).

Friedman et al., 2014; predicted a final reduction in worldwide atmospheric levels of PAHs due to a minimal rise in volatile PAHs and a remarkable decrease in non-volatile PAHs. Exposure of employees are likely to be influenced more directly by local sources of PAHs production where burning of the organic material occurs as in coke and petroleum based-fuel combustion. Outdoor worker exposure to PAH concentrations, for example, might be reduced by using cleaner-burning fuels and electric means of transportation (Friedman et al., 2014).

Unlike the other contaminants described, climate change may have a variety of effects on PAH exposures. With rising temperature and light intensity, low molecular weight PAHs might rapidly volatilize. In contrast, photodegradation rates of medium and high molecular weight PAHs differ, potentially resulting in the production of more toxic by-products or metabolites. While people may be subjected to less PAHs in the near future, they may be exposed to new metabolites of these pollutants, which might be even more hazardous (Marquès et al., 2016).

Other Chemicals

Chemical exposures are expected to rise as a result of climate change due to a variety of factors, including increasing pesticide usage, changes in transport modes such as dust proliferation, enhanced chemical dispersal from storm runoff, and higher chemical spills due to floods and fires (Luber et al., 2014).

Agricultural tilling and harvesting are important transportation routes for particulate dust and particle-bound pollutants in the atmosphere. Soil dust has been related to a variety of adverse effects on human health. Elevated levels of dust in hot and dry weather will result in particle and chemical exposure. Changes in climate will most likely influence chemical and pathogen transport channels and fate

processes, affecting exposure levels based on chemical characteristics (hydrophobicity, solubility, volatility) and contaminant form (particulate, particle associated, dissolved) (Noyes et al., 2009).

In farming techniques, conditions are more favorable for the proliferation of insect pests in warmer climates. In addition, altered wind patterns may change the spread of both wind-borne pests and of the bacteria and fungi that are the agents of crop and livestock diseases. Consequently, pesticides and biocides are expected to be used more often as a result of climate change, potentially increasing occupational exposures. Increased usage of veterinary drugs to combat temperature-related increases in livestock epidemics is also expected, putting veterinary experts and food animal producers at risk in different ways (Kemper et al., 2008).

Extreme weather events will possibly release pollutants from soils and faeces, enhancing their bioavailability. Increased pollutant discharge paired with rising temperatures poses an increased danger to employees in a variety of industries, including agriculture, energy, construction, hazardous waste, and emergency management (Bloomfield et al., 2006).

Pathogenic Microorganisms

Workers who work in close proximity to the natural environment or who come into touch with polluted soil, water, animals, or infrastructure are more likely to be exposed to harmful microorganisms. The majority of research have discovered a link between rainfall levels and the occurrence of infectious illnesses such gastrointestinal infections (Curriero et al., 2001).

A changing climate might have an impact on the development of various animal species and food-animal production systems, altering the animal-human interface and providing new circumstances for infectious diseases onset. Workers in the forestry, agricultural, animal husbandry, and meat handling industries are the most likely to be affected. Tick-borne encephalitis, tularemia, brucellosis, leptospirosis, rabies, and anthrax are among the dangers. Moreover, studies have shown that warming of the sea surface might augment the level and spread of Vibrio species, thereby increasing the risk of human infectious illnesses among fishermen (Altizer et al., 2013).

Vector-borne infectious agents

Increased intense rain events may have a detrimental impact on those working in locations with inadequate

water drainage, which provides mosquito breeding grounds. Rift Valley fever, yellow fever, malaria, dengue fever, and chikungunya are vector-borne illnesses that are susceptible to climate change, and research predicts that many of these diseases will increase their geographic range, raising their toll on human health. Rift Valley fever in animal populations can lead to human illnesses, making this a particularly dangerous situation for animal agriculture workers, meat processors, and veterinarians. Abattoir workers, cattle ranchers, and veterinarians who have regular contact with animals had a considerably greater rate of Rift Valley Fever infection (Archer et al., 2011).

Workplace Violence

Various occupations, such as law enforcement, security personnel, armed forces, disaster response personnel, emergency medicine, firefighters, homeland security, and border security, as well as aid organizations like the Red Cross, will face an increase in the risk of injury and mortality as conflict increases.

Climate change is expected to promote conflict in general, as climate change amplifies weather disasters and destabilizes food and water supplies. In countries where climate change leads to drought or reduced harvest or destroys critical infrastructure and displaces communities, the risk of conflict is exacerbated. Interpersonal violence shows a link between rising temperatures and conflict. Although exact associations differ between researches, violent crime, rape, and violent intergroup revenge are all typically positively connected with higher temperature. In both experimental and in general life situations, such as hostility among athletes at sporting events and domestic violence incidents, excessive heat and human aggression have been seen. One example is police officers' hostility as a result of high temperatures during training exercises. Officers were shown to be more likely to get violent or draw their firearm on an attacker in training rooms with higher temperatures (Hsiang et al., 2013).

Wildfires

Changes in wind patterns, temperature, and moisture levels caused by climate change will affect the frequency and extent of wildfires, whether they are caused by natural (e.g., lightning strikes) or human activities. Controlling wildland fires necessitates a significant amount of work all around the world, and fighting these flames

entails the risk of occupational harm or even death. Increased vulnerability to occupational morbidity and death might be predicted if the number or intensity of wildland fires rises (Britton et al., 2013).

Predicting wildfire danger is tough, and it becomes much more difficult when climate change is taken into account. Fires require a source in addition to the proper physical conditions. Most of researches implied that certain locations might observe changes in conditions that promote fires as a result of climate change, concentrating on physical factors (topography of the area and presence of fuel in addition to weather conditions). As a result of climate change, the incidence and magnitude of wildfires may change, affecting the mortality and morbidity associated with firefighting and, as a result, the risk of occupational injury or death among wildland firefighters (Moritz et al., 2012).

Recommendations

It is critical for companies to understand how climate change could affect their employees' health and safety. Employers; starting from now, should include climate change factors into current safety and health training. Workers presently experiencing the health effects of climate change might benefit from existing tools and techniques for protecting themselves against climate change-related dangers such as temperature extremes and the bad health effect of pesticide usage. These methods and approaches can also be used to prepare for the future prevention of health effects on susceptible occupational groups (NIOSH, 2018; OSHA, 2021)

Employers

To safeguard employees, employers must employ management and engineering solutions. Workplace improvements such as workplace cooling systems, which apply environmentally friendly technology or designs, would immediately reduce illnesses and early mortality caused by air pollution and intense heat. All employees, especially younger and older working-age groups, would benefit from the introduction of heatstroke preventive programs—and adaptation strategies. Employers in poor nations must regularly train personnel on the proper use of personal protective equipment (PPE) and educate them on how to avoid the lifestyle choices that enhance their risk of acquiring climate-related illnesses (Lundgren et al., 2013).

Periodic safety inspections will include heat stress evaluation as well, which will aid in the development, elimination, and replacement of

engineering controls, administrative controls, and personnel protective approaches. In workplaces most exposed to hot and humid environment conditions, the essential features of PPE must be appropriately controlled (Alele et al., 2020)

Policymakers and the government

In poor nations, governments and policymakers must clearly identify accident and illness indices and gather data to enable epidemiological monitoring of climate change-related health consequences. In addition, present and future occupational health principles and requirements must be connected to climatic parameters and physiological systems in order to foresee changing climatic implications and prospective repercussions on worker health and safety. Because the majority of their workforce is employed in the informal sector, developing nations should also adopt comprehensive education and training initiatives. Governments must invest in teaching farmers and traders on the effects of climate change, as well as the types and proper use of personal protective equipment (PPE) and other safety rules. Despite this, most poor nations have little or ineffective occupational health and safety policies. As a result, effective and comprehensive health and safety standards and regulations must be addressed at both the national and institutional levels to govern all types of jobs and workplaces (Ansah et al., 2021).

Workers

Climate change will likely have a greater influence on workers in the future. As a result, in developing nations; they must be informed about climate change, its effects on health, what they can do to help, and how to adapt. Workers must be aware of lifestyle choices that make them less vulnerable to the bad health effects of climate change. Workers must also exercise on a regular basis to maintain their good health, while their unions campaign for worker protection programs such as reducing workplace pollution and CO_2 generation, as well as worksite health and safety procedures. PPE must serve as a primary barrier to protect employees from serious injury or illness. Workers must be aware of the health implications of climate change, as well as how to use and maintain personal protective equipment (PPE) in order to preserve its long-term viability (OSHA, 2018).

Conclusion

Climate change increased the risk of work-related diseases and injuries,

necessitating steps to enhance the detection and prevention of its impact on the occupational health. Clinicians, public health professionals, and others need to be trained in detecting and properly diagnosing climate-related medical diseases among employees, particularly heat-related illnesses, as well as assisting in their prevention.

Designing and implementing interventions directed at the workplace, such as limiting physically demanding work during excessive heat, having air conditioners available whenever possible, and arranging essential break times throughout work shifts, are all part of the prevention of work-related diseases and accidents. It also entails developing and executing worker-focused initiatives, such as giving enough information and training to minimize heat-related illnesses, providing lighter work clothing or suitable PPE, and ensuring sufficient hydration.

Climate change worsens current workplace health and safety issues while also introducing new ones. It poses several issues that need the development of new ideas and better approaches to prevention.

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