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Review

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Review

The Global Climate Crisis is associated with Environmental Risks and Heat Stress impacts on Occupational Safety, Health, and Hygiene

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Abstract: The relationship between the global climate crisis associated with environmental risks and occupational hygiene has not been extensively studied. This study develops a framework for identifying how climate change and the climate crisis could impact the workplace environment, workers, and occupational morbidity, mortality, and injury. A framework based on a review of scientific literature published from 2012-2024 that addresses climate risks, their interaction with occupational hazards, and their effects on the workforce. Eight categories of climate-related hazards are identified: increased high temperatures, dust and air pollution, sun and cosmic ultraviolet exposure, pandemics and infectious diseases, diseases transmitted by insects and changes in ecosystems, industrial occupational diseases, changes and crises in the built environment, and extreme weather events. It is important to consider the possibility of interactions between known hazards and new conditions and the productivity of workers, especially those who are most at risk of heat-related illnesses.

Keywords: global climate crisis; environmental risks; heat stress; occupational safety; public health; public hygiene

1. Introduction

The climate crisis represents one of the most pressing issues today. It leads to profound changes in environmental conditions. Consequently, these changes dramatically impact occupational hygiene, health and safety. Understanding these dynamics is essential for protecting all employees, and workers. Research indicates that rising temperatures correlate with increased health risks. Heat stress has become a prominent concern in various industries and its effects compound with other environmental risks especially during the last decade during climate change and crisis. These include air pollution, water scarcity, and extreme weather events, increase workers health, and occupational morbidity, mortality, and injury [1]. The well-being of employees is jeopardized not only by heat-related illnesses but also by the adverse effects of high temperatures on their performance and work capacity, engaging in physically demanding tasks under hot and humid conditions, alongside the necessity of wearing protective equipment, can impose significant and potentially hazardous stress on a worker's body [2]. Although there are established methods and international benchmarks to mitigate heat-related challenges in the workplace, these guidelines have primarily been created for cooler climates and may not be applicable to all regions due to variations in geography, culture, and

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economic conditions [3]. Studies indicate that workers in low- and middle-income countries located in tropical areas are especially susceptible to extreme heat exposure, this vulnerability is compounded by factors such as crowded working environments, prevalence of informal employment sectors, and escalating temperatures because of climate change [4]. Key role of the study to investigate both the present and future risks linked to working in elevated temperatures and propose strategies to safeguard the health and productivity of workers, particularly those most exposed to heat-related health issues during the Global Climate Crisis. The assessment of productivity loss resulting from climate change has so far been focused on physiological models of heat exposure [5,6]. Heat stress at work is also an occupational health hazard that lowers public health inspectors, and labour productivity especial in climate crisis or extreme weather events, [5–11]. To control heat stress need and provide the Personal Protective Equipment and Measures (PPEM), [7–11]. Policies must evolve in response to the changing climate, and suggested actions as workplace guidelines, and develop recommendations for safe working conditions also at high temperatures. This study aims to present a comprehensive view of the concerns surrounding occupational hygiene, safety and health in the context of climate change. It also focuses on the development of a framework for the identification of how climate change and the climate crisis could impact the workplace environment. The scope of this study is to improve that the global climate disaster has a profound impact on occupational safety, health, and hygiene. Heat stress is a significant risk factor for workers worldwide. As a result, integrating effective mitigation methods is critical. Future studies must continue to investigate these connections. Faced with the threat of climate change, society must prioritize worker safety.

2. Materials and Methods

This is a scoping review of selected 45 articles-reviews published from 2014–2024 about climate risks, their interaction with occupational hazards, and their effects on the workforce. The review process followed a systematic methodology, all the records identified through database searching (n = 259), in the Figure 1 show the PRISMA flowchart of the selection of articles including in the scoping review [12]. The authors searched multiple databases, including PubMed- Scopus- Web of Science- Google Scholar, MEDLINE, and other databases.

Keywords included: Global Climate Crisis - Climate Change - Occupational Safety - Heat Stress - Environmental Risks - Occupational Health – Hygiene.

Inclusion criteria:

-Peer-reviewed articles

-Articles focusing on occupational health, heat stress and climate change

-Articles in English language

Inclusion Criteria

Studies met the following criteria for inclusion:

- Peer-reviewed articles
- Research focusing on occupational health
- Studies discussing heat stress in relation to climate change
- Available in English

Data Extraction

The authors extracted relevant data from selected studies. This included:

- Study location
- Sample size
- Key findings
- Statistical analyses

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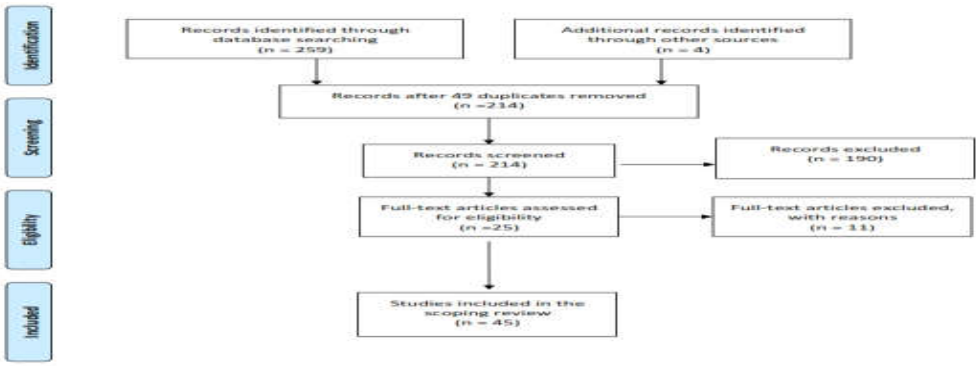

Figure 1. PRISMA flowchart of the selection of articles included in the scoping review [12].

The perspective scoping review included 45 studies, revealing critical insights:

-Heat Stress and Its Effects.

- Studies consistently show that increased temperatures lead to higher incidences of heat-related illnesses.

- Common health issues include heat exhaustion and heat stroke.

- Environmental Risks.

- Air quality significantly deteriorates during extreme heat events. This worsens respiratory conditions in workers.

- Water scarcity leads to dehydration, exacerbating heat stress.

Thus, this scoping review aims to synthesize current literature on these interconnected issues. Ultimately, enhancing our understanding will inform better practices and policies that improve occupational safety and health amid the global climate crisis.

3. Results

This scoping review intends to achieve several objectives, including assessing research activity, determining the value of full reviews, summarizing and disseminating research findings, identifying gaps in existing literature, and creating diagrams with associated findings. Reveals also the following critical insights results.

Eight categories of climate-related hazards were identified:

1) Increased high temperatures,

2) Dust and air pollution,

3) Sun and cosmic ultraviolet exposure,

4) Pandemics and infectious diseases,

5) Diseases transmitted by insects and changes in ecosystems,

6) Industrial occupational diseases,

7) Changes and crises in the built environment,

8) Extreme weather events.

Provided crucial data for air quality as significantly deteriorating during extreme heat events, also worsens respiratory conditions in workers, increased temperatures lead to higher incidences of heat-related illnesses. Common health issues include heat exhaustion and heat stroke, Water scarcity leads to dehydration, exacerbating heat stress. Extreme temperatures increase emergency room visits, and the higher instances of heat-related illness in outdoor workers finally the positive correlation between heat stress and workplace accidents. Figure 2 shows the Global Climate Crisis regarding Environmental Risks and the impact of Heat Stress on Occupational Safety, Health and Hygiene after analyzing the reviews data.

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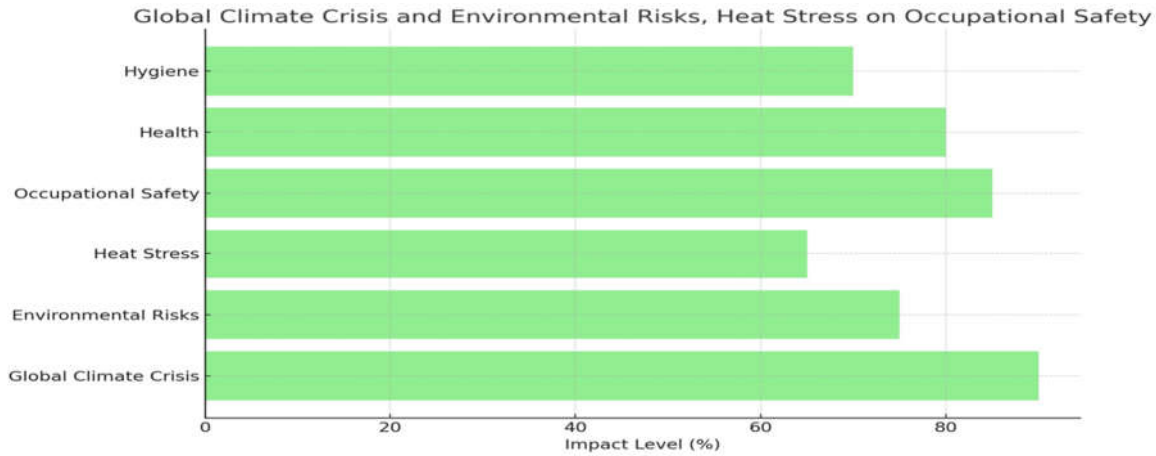

Figure 2. The Global Climate Crisis regarding Environmental Risks and the impact of Heat Stress on Occupational Safety, Health and Hygiene (Adamopoulos et al, 2024).

The results of this study aim to establish the effectiveness of a targeted intervention while also offering essential recommendations for mitigating heat stress during extreme weather events, particularly in the context of the *Global Climate Crisis*. It will assess the public health implications, specifically regarding occupational safety, health, and hygiene in the workplace, as well as the quality of implementation. Additionally, it will play a significant role in proposing comprehensive workplace and labor inspection regulations designed to reduce health hazards for millions of employees and workers. Employees and workers who are exposed to excessive heat, work in hot surroundings indoors or outdoors, or participate in hard physical activity may be at risk for heat stress. Extreme heat exposure can produce heat stress-related occupational disorders such as heat stroke, heat exhaustion, heat syncope, heat cramps, heat rashes, and mortality. Heat can further enhance workers' risk of injury by causing sweaty palms, fogged-up safety glasses, disorientation, and a reduction in brain function responsible for reasoning abilities, which creates additional risks [13]. Mathematical methods to calculate Wet bulb globe temperature (WBGT) from weather is the most widely used occupational heat tool for the assessment of heat stress,[14]. This pertains to evaluating the average impact of heat on humans during an eight-hour workday and hourly labor period [15]. Work rest cycles and WBGT reference values are not applicable to evaluating heat stress over short durations [15].

Mathematic Formula for Inside buildings measures without solar radiation:

$$WBGT = 0.7T_{nw} + 0.3T_g \quad (1)$$

Formula with environmental measurements include solar radiation levels outside structures:

$$WBGT = 0.7T_{nw} + 0.2T_g + 0.1T_a \quad (2)$$

The natural wet bulb temperature ($\mathbf{T_{nw}}$) is measured with a wet wick thermometer exposed to local air movement and radiation, while ($\mathbf{T_g}$) is the temperature in the center of a 150 mm. , diameter of a black globe The air temperature ($\mathbf{T_a}$) is insulated from radiation yet allows for air circulation near the sensor. The indices examined include the WBGT, the Discomfort Index, the Predicted Heat Strain Index, and the Universal Thermal Climate Index. In some instances, individuals may be monitored for heat strain through physiological evaluations and medical assessments both prior to and during exposure to high temperatures. Additionally, relevant protective and preventive strategies aimed at mitigating heat strain are reviewed and recommended. The climate extreme events and heat stress have had a significant influence on the economy and energy negative costs. The Figure 3 depicts the amount of electricity consumed by the typical U.S. throughout the summer to June, July until August of each year from 1973 to 2022, with the dashed line representing the average number of cooling degree days for the same months [16].

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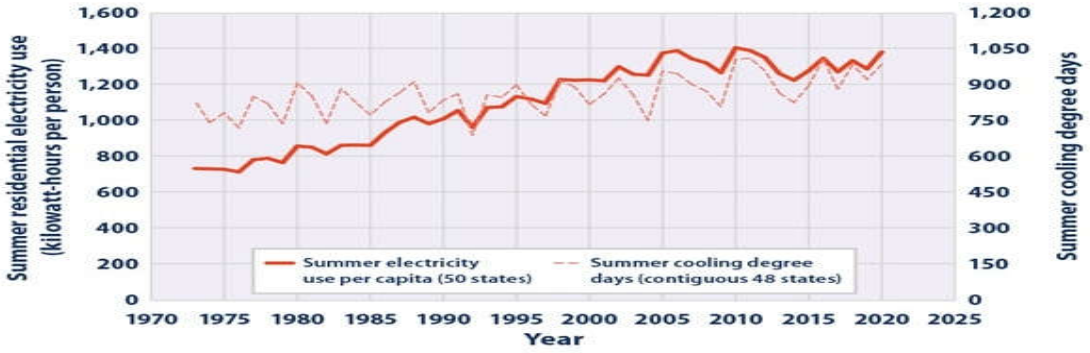

Figure 3. Residential Summer Electricity Use per Capita and Summer Cooling Degree Days in the United States, 1973–2022 Sources EIA, 2022 [16].

The results of the consequences of global warming are undeniably set to exacerbate the effects of heat on workers in already hot environments, particularly in regions with elevated temperatures. As this environmental health challenge becomes more widespread, it is essential to enhance our assessment methods. Innovative approaches are necessary to better understand the magnitude of the issue and to develop suitable interventions at the individual, workplace, and societal levels. Assessing occupational heat stress entails evaluating four key thermal factors: i) air temperature, ii) humidity, iii) air velocity, and iv) heat radiation. Existing weather station data can be useful for measures and analysis. However, utilizing meteorological data for assessing occupational heat stress is often insufficient, as traditional weather stations typically do not directly measure certain critical climate factors, such as solar radiation. Furthermore, the specific conditions within a workplace, local heat sources, metabolic heat generated by the body, and the properties of clothing, significantly influence the body's heat exchange with the environment. Thus, a comprehensive occupational heat stress index must consider all these variables. The schematic representation of the literature search is represented graphically in the diagrams of the following Figures 4 and 5. The potential repercussions of occupational heat stress, exacerbated by climate change and extreme weather events, bear substantial implications for employees, workplaces, labor inspectors, and public health services, ultimately affecting global economies. The challenges related to occupational health, safety, hygiene, and the threat of heat stress are expected to become particularly acute in tropical and subtropical regions with middle- and low-income economies. Over recent decades, the climate crisis has influenced nations globally, often where effective management solutions are not readily accessible. Future initiatives must tackle the shortcomings of current heat stress evaluation techniques, focusing on developing cost-effective, practical, and adaptable strategies that can accommodate data at various levels of granularity, depending on the resources at hand. It is crucial to implement new regulations, guidelines, and methodologies in diverse settings, while also centralizing the collection and analysis of global policy data for both local and broader-scale hazard assessments. This will inform effective planning for heat stress adaptation. Standards for heat stress should consider variations in worker acclimatization, pre-existing vulnerabilities, and available workplace resources. Additionally, the effectiveness of viable and acceptable control strategies needs to be systematically evaluated. Collaboration among public health experts, environmental scientists, policymakers on a global scale, and international governments is vital to successfully prevent and manage occupational heat stress within the context of a climate crisis. Figure 4 describes all research that has used and made upon literature, shows the schematic representation flow chart of the study: The Global Climate Crisis is associated with Environmental Risks and Heat Stress impacts on Occupational Safety, Health, and Hygiene.

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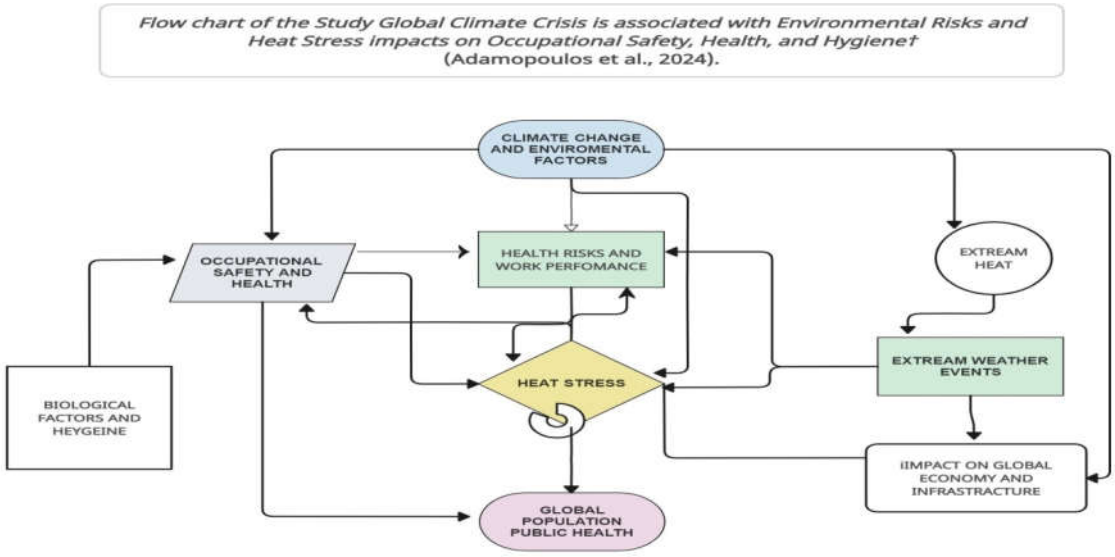

Figure 4. The schematic representation flow chart of the study: The Global Climate Crisis is associated with Environmental Risks and Heat Stress impacts on Occupational Safety, Health, and Hygiene.

Belongs the Figure 5 describes all research has made and used upon literature and show the schematic representation illustrates the correlation between the study of environmental public health, occupational safety, health, and hygiene concerning workplace risk factors.

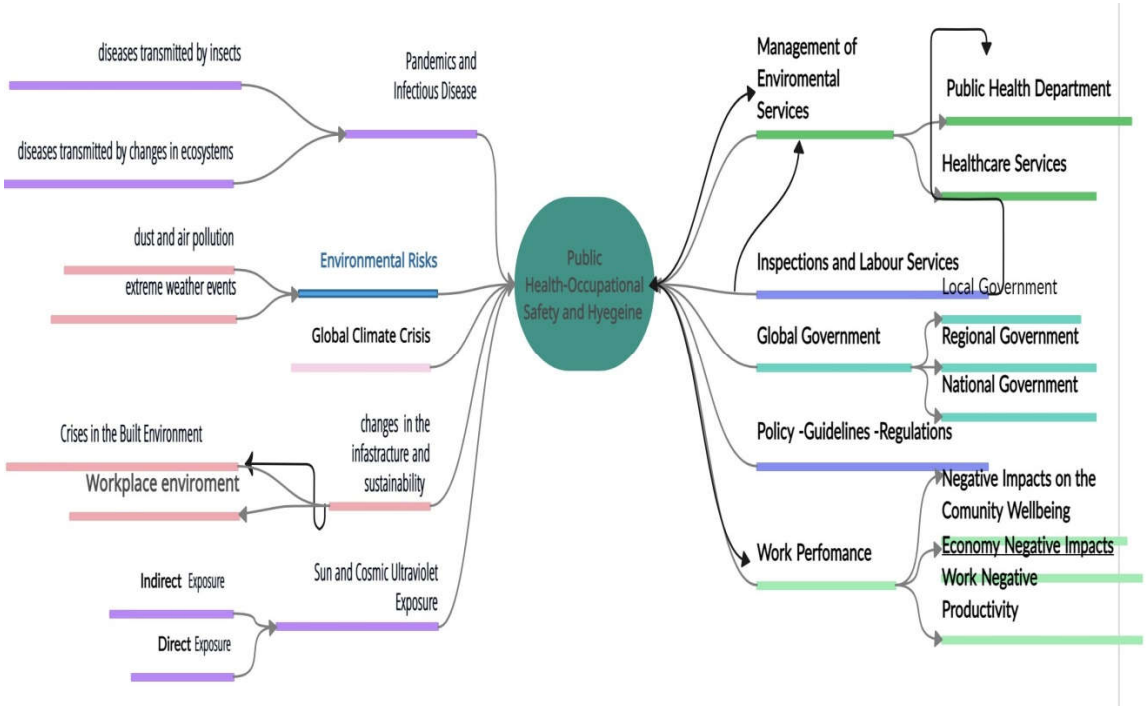

Figure 5. The schematic representation illustrates the correlation between the study of environmental public health, occupational safety, health, and hygiene concerning workplace risk factors.

This study, along with its accompanying Figures 4 and 5, elucidates the connections and interrelations of occupational heat stress in relation to climate change, examining its impacts and reflecting on its significance for assessing and mitigating heat stress, as well as its detrimental effects on public health, [17–43].

4. Discussion

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Effective prevention and management of occupational heat stress considering climate crisis requires robust collaboration among public health specialists, environmental scientists, policymakers on a global level, and international governments. The updated guidelines and new standards regarding heat stress are clearly outlined by OSHA [44]. This initiative underscores the critical importance of hydration, mandating employers to supply cool drinking water and establish shaded areas for workers to take breaks and recover from heat exposure [44]. Numerous studies have demonstrated that increasing water intake serves as an effective behavioral adaptation to help prevent heat-related injuries among workers, particularly in outdoor settings [45–49]. Research conducted among Chinese workers indicated that providing cool drinking water is the most widely adopted preventive strategy during periods of hot weather [50]. Additionally, offering electrolyte solutions, potassium-rich fruits, and pickles significantly enhances workers' safety and boosts productivity by replenishing essential minerals lost due to heat, thus combating dehydration and minimizing the risk of cramps. Water and electrolyte supplements are provided to workers to ensure they stay hydrated during their shifts and perform their duties safely. These insights are consistent with earlier findings involving workers, which noted that the provision of clean drinking water and scheduled shade breaks, accompanied by increased access to water, effectively mitigated the adverse effects of heat stress on kidney function and injury prevention [51–57]. Availability of resources fosters a supportive environment, enabling workers to take breaks without negative consequences, thereby enhancing safety and reducing heat stress risk.

5. Conclusions

Climate change is significantly increasing the rates of illness and death, largely due to extreme weather events and pollution. To address these pressing issues effectively, health policies must evolve on both local and global scales. The health impacts of climate change are diverse, affecting various population groups in different ways. It is essential to foster international cooperation and invest in preventive measures and adaptive strategies to reduce these risks. Furthermore, the need to explore hazards may interact with new challenges, particularly regarding their implications for worker productivity, especially among those most susceptible to heat-related health problems. There is a necessity for new regulations and approaches to standardize the collection and analysis of global policy data, which will improve hazard assessments at both local and broader levels and support the creation of effective strategies for adapting to heat stress.

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Conflicts of Interest: The authors declare no conflicts of interest.

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