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INFLUENCE OF CLIMATE CHANGE ON OCCUPATIONAL RISK PREVENTION IN CONSTRUCTION SITES, A SYSTEMATIC REVIEW

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ABSTRACT

Climate change is increasingly affecting working conditions in the construction sector, exposing workers to extreme heat, solar radiation, and other climatic hazards that compromise health and safety. This systematic review analyses the main scientific evidence published between 2015 and 2025 on the influence of climate change on occupational risk prevention in construction sites. This period was selected because it captures the decade in which scientific and regulatory attention to climate-related occupational risks increased most significantly. The methodology followed the PRISMA approach, including eight key studies on thermal stress, perception of risk, preventive measures, and psychosocial factors, complemented by recent reports from EU-OSHA and ISO 45003. Findings indicate that heat stress and fatigue are the most frequent risks, while organizational and psychosocial aspects significantly affect safety behavior. Despite growing awareness, adaptation measures remain insufficient. This study highlights the need to integrate climatic and psychosocial risk management into occupational health and safety systems in the construction sector.

Keywords: Prevention, Occupational Health, Construction Sector, Climate Change, PRISMA.

INTRODUCTION

Climate change is one of the major challenges of the 21st century. The European Union recognizes it as a direct threat not only to ecosystems but also to Occupational Health and Safety (OHS), as outlined in the EU Strategy on Adaptation to Climate Change (European Commission, 2021). Consequently, the European OHS Strategy (2021–2027) and Framework Directive 89/391/EEC urge Member States to integrate climate-related risks into their preventive policies. Climate change is silently reshaping working conditions and traditional risk prevention models. Rising temperatures, increased frequency of extreme weather events, and variations in solar radiation and humidity have introduced new hazards that current prevention systems fail to manage effectively (Rossi *et al*., 2025; Abdul-Nabi *et al*., 2025). These environmental phenomena are referred to in the literature as "climate-related occupational risks," defined as risks arising from exposure to environmental factors that affect both physical and mental health at work.

The construction sector is particularly vulnerable to climate change because most activities take place outdoors and are highly dependent on environmental conditions. Consequently, workers are increasingly exposed to heat waves, intense solar radiation, heavy rainfall, and air pollution, which heighten both physical and mental fatigue and increase the likelihood of accidents (Rossi *et al*., 2025; Zhu *et al*., 2025; EU-OSHA, 2024). According to the report "Climate Risks: 1 in 3 Workers Are Exposed and Raise Concerns over Health and Safety Impacts — New OSH Pulse Survey Reveals" (EU-OSHA, 2024), one in three European workers faces climate-related risks,

with construction among the most affected sectors. In the specific case of Spain, data from the National Working Conditions Survey indicate a high level of exposure to extreme thermal environments in the construction sector, particularly in central and southern regions of the country where heatwaves have intensified in recent years. These findings reinforce the relevance of examining climate-related occupational risks in the Spanish context. Approximately 23% of exposed workers experience heat stress, including fatigue, dizziness, and reduced attention span, which directly impacts productivity and accident risk. However, this phenomenon should not be understood solely in terms of high temperatures, as other factors such as rain, cold, and humidity also pose significant hazards. Recent studies confirm this growing vulnerability: Rossi *et al*. (2025) and Habibi *et al*. (2025) reported increased dehydration, fatigue, and kidney disorders among workers during extreme heat episodes. Zhu *et al*. (2025) demonstrated through neurophysiological techniques that prolonged heat exposure impairs reaction time and attention, thereby increasing the likelihood of workplace accidents.

Climate change not only exacerbates physical hazards but also intensifies psychosocial risks in the workplace. Extreme temperatures and pressure to meet deadlines can lead to anxiety, mental fatigue, and frustration. Therefore, it is essential to consider the psychosocial dimension as an integral part of climate-related impacts on occupational health. In this regard, Martin *et al*. (2025) and Priolo *et al*. (2025) emphasize that anxiety, precautionary behavior, and risk perception significantly influence safety decisions and the adoption of preventive measures. Furthermore, Pomeroy and Pilbeam (2025) point out that conventional safety metrics may obscure the real effects of climate change, as they focus solely on recorded accidents without accounting for emotional or environmental factors. Consequently, Occupational Health and Safety (OHS) management systems should evolve toward an approach that integrates both physical and psychosocial risks arising from changing climatic conditions.

These conditions, in addition to creating physical hazards, also lead to stress, anxiety, and psychological pressure due to the need to meet deadlines under adverse circumstances. The European regulatory framework acknowledges the importance of addressing these psychosocial factors as part of preventive management. In this context, ISO 45003:2021 provides guidance for incorporating the psychosocial dimension into Occupational Health and Safety (OHS) management systems (ISO, 2021). Applying this standard in the construction sector would enable a more comprehensive approach to the mental effects of working under environmental stress, thereby strengthening organizational climate resilience and improving overall quality of working life.

Despite recent progress, scientific publications still reveal significant gaps. Most studies focus exclusively on heat, while other climate-related hazards such as rain, wind, or cold remain underexplored (Abdul-Nabi *et al*., 2025; Man *et al*., 2025). Moreover, evidence specific to construction sites is limited and highly uneven, with few quantitative studies assessing the actual effectiveness of implemented adaptation measures (Habibi *et al*., 2025). These knowledge gaps justify conducting a systematic review that synthesizes findings from the past decade, providing a foundation for developing new strategies tailored to the climate-related challenges identified.

In summary, the introduction progresses from a general description of climate change and its regulatory implications to the identification of specific physical and psychosocial risks in the construction sector. This progression situates the topic within a regulatory and analytical framework, thereby facilitating a clear understanding of the objectives guiding the systematic review.

This context also explains the choice of keywords: prevention, occupational risks, construction, and climate change. These terms represent the core of the problem and enable precise database

searches. The literature considered in this review encompasses studies published over the past decade (2015-2025) and available in English or Spanish, reflecting the most relevant and accessible scientific contributions on climate-related occupational risks in the construction sector. The PRISMA methodology was chosen because it provides a transparent and reproducible structure for systematic reviews. This approach is particularly useful when analysing an emerging field with dispersed studies, such as the relationship between climate change and occupational risk prevention in the construction sector, ensuring the quality and reliability of the research selection process.

Building on these considerations, the objective of this review is to provide a structured and up-to-date synthesis of scientific evidence on how climate change affects occupational risk prevention in the construction sector. This includes examining the main impacts reported in the literature, reviewing the preventive and adaptive measures proposed by recent studies, considering how climate-related risks can be incorporated into existing occupational safety frameworks, and outlining elements that may enhance the resilience of work environments under increasing environmental stress.

Materials and Methods

Based on the general objective outlined in the Introduction, this section defines the specific aims that guide the methodological process of the review:

- Identify the main impacts of climate change on Occupational Health and Safety (OHS) in the construction sector.
- Review proposed preventive measures and adaptation strategies.
- Assess the need to integrate climate risk management into preventive standards, in accordance with ISO 45003:2021 (ISO, 2021) and EU-OSHA recommendations (2024).
- Propose ideas to enhance the resilience of work environments against environmental challenges.

To achieve this objective, a systematic literature review was conducted following the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), ensuring transparency and reproducibility throughout the process (Liberati *et al.*, 2009; Page *et al.*, 2021). The decision to apply the PRISMA methodology reflects the need for a transparent, systematic and reproducible structure, particularly suitable for emerging research fields in which studies are dispersed, such as the relationship between climate change and occupational risk prevention in the construction sector. This approach helps minimise selection bias and ensures the methodological rigour and consistency of the review process. The procedure involved four stages: (1) identification of records across the selected databases, (2) screening of titles and abstracts to remove duplicates and non-relevant studies, (3) full-text eligibility assessment based on predefined inclusion and exclusion criteria, and (4) final inclusion of studies meeting all requirements. The entire process was documented in a PRISMA flow diagram (Figure 1), which illustrates the number of articles identified, screened, excluded, and finally included, ensuring full traceability of the review. The selected articles were analysed descriptively, examining variables such as the type of risk addressed, methodological approach, proposed preventive measures, and the presence of regulatory factors. This approach allows for the identification of common trends and research gaps.

Scopus was chosen as the primary database due to its extensive coverage of scientific literature, while Web of Science and PubMed were used as secondary sources to validate results and ensure comprehensive sampling. The search was conducted between September and October 2025.
Keywords included: "prevention," "occupational risks," "construction," and "climate change," along with "systematic review" as a test term to verify whether previous studies addressed the same topic. The selection of these keywords reflects the need to delimit the core of the research question with precision, enabling a structured and replicable search across scientific databases. These terms capture the conceptual pillars of the study (climate change, the construction sector, and occupational risk prevention) and facilitated the identification of research directly aligned with the objectives of the review.
Keywords were combined using Boolean operators: ("prevention" AND "occupational risk") AND ("construction" OR "climate change") AND ("systematic review").
Additional terms frequently appearing in the literature were included to broaden and refine the search results: ("global warming" OR "heat stress" OR "extreme weather").

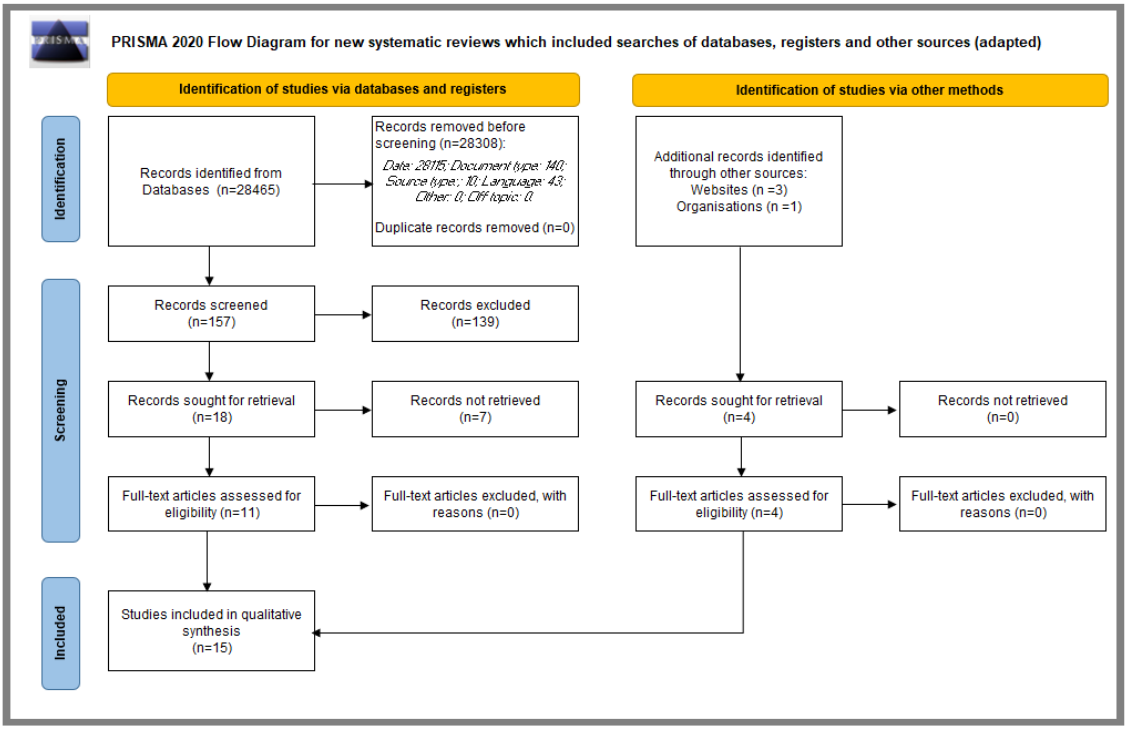

Figure 1: *Flowchart illustrates the selection of studies using the PRISMA method.*

The study period was defined as 2015–2025, corresponding to the past decade, during which scientific output on the effects of climate change on occupational health and safety increased substantially, alongside the development of regulatory frameworks and adaptation strategies at both European and international levels. The review therefore considered articles published between 2015 and 2025 that were available in English or Spanish and accessible in open-access format.
Studies were selected only if they directly addressed the relationship between climate change and occupational risks in the construction sector. Articles that examined climate-related occupational risks without focusing on construction were excluded, as were those dealing solely

with climatological research unrelated to OHS, conference abstracts, and duplicate publications across databases.

After applying these criteria, eleven articles from Scopus met the inclusion requirements (Rossi *et al*., 2025; Abdul-Nabi *et al*., 2025; Zhu *et al*., 2025; Habibi *et al*., 2025; Martin *et al*., 2025; Priolo *et al*., 2025; Pomeroy & Pilbeam, 2025; Man *et al*., 2025; Min *et al*., 2025; Acharya *et al*., 2018; Han *et al*., 2024). Additional sources were incorporated to provide context and strengthen the discussion (EU-OSHA, 2024; ISO, 2021; Kjellstrom *et al*., 2016; Xiang *et al*., 2014; ILO, 2019).

During the initial phase, another relevant publication was reviewed (Nazneen *et al*., 2025), which offered an interesting perspective on climate change and monitoring technologies but was excluded from the analysis for not meeting the inclusion criteria. Nevertheless, it was considered useful for understanding the diversity of existing approaches.

Finally, during the screening phase, additional relevant studies were consulted (Habibi *et al*., 2024; Carolina & Wijaya, 2025; Ghaisani & Susilowati, 2025), addressing topics such as the adoption of safety technologies, cognitive effects of heat, and the impact of climate change on on-site performance. These references include normative documents such as ISO 45003:2021 (ISO, 2021), recent institutional reports, and international reviews on the adaptation of occupational safety systems to climate change.

The main limitations of this study stem from the scarcity of scientific literature focused specifically on the construction sector, the methodological heterogeneity among studies, and the lack of empirical data on the effectiveness of preventive measures. The limited number of studies ultimately included in this review reflects the emerging nature of research on climate-related occupational risks in the construction sector. Although scientific output on climate change and worker health has increased in recent years, the evidence remains fragmented across disciplines and often lacks a direct focus on construction activities. In addition, methodological heterogeneity (particularly differences in study design, outcome measures and contextual factors) reduced the number of articles that met the predefined inclusion criteria. These structural characteristics of the literature, rather than the search parameters alone, largely explain the final size of the evidence base.

The small number of included articles reflects the emerging nature of the topic and the need to expand research in the coming years. Several studies identified during the initial phases (Nazneen *et al*., 2025; Habibi *et al*., 2024; Carolina & Wijaya, 2025; Ghaisani & Susilowati, 2025) did not meet the inclusion criteria, highlighting the thematic diversity among publications addressing climate change and occupational risk prevention. Nevertheless, this review provides a comprehensive and up-to-date overview of the phenomenon, serving as a solid foundation for developing prevention strategies adapted to the current climate context.

Results and discussion

The analysis of the selected articles reveals patterns in research on climate change and Occupational Health and Safety (OHS) in the construction sector. Notably, most of the studies were published between 2022 and 2025, indicating growing interest in this field. Although methodological approaches vary, ranging from systematic reviews (Rossi *et al*., 2025; Habibi *et al*., 2025; Priolo *et al*., 2025), experimental studies (Zhu *et al*., 2025; Min *et al*., 2025), evaluations of implemented interventions (Acharya *et al*., 2018; Han *et al*., 2024), and psychosocial analyses (Martin *et al*., 2025; Priolo *et al*., 2025; Man *et al*., 2025), all agree that climate change introduces risks requiring new preventive strategies. To facilitate comparison and interpretation of the

included studies, Table 1 summarises their main methodological characteristics, the climate-related risks examined and the preventive contributions identified.

Regarding physical hazards, the findings consistently highlight extreme heat as the climatic phenomenon with the greatest impact on OHS in construction. This is reflected in the analyses by Rossi *et al*. (2025), Abdul-Nabi *et al*. (2025), and Habibi *et al*. (2025), which report increases in fatigue, dehydration, and heat stress, as well as associated conditions (particularly kidney disorders) linked to prolonged exposure to high temperatures. These effects are further intensified by the demanding physical activity typical of construction work, limited opportunities for breaks, and direct sun exposure. Zhu *et al*. (2025), in an experimental study, reinforce these results: using functional spectroscopy, they demonstrated that sustained heat exposure deteriorates attention and slows cognitive responses, thereby increasing the likelihood of workplace accidents, especially during the final hours of the workday when fatigue is greatest. Several studies have attempted to quantify the association between rising ambient temperature and accident rates; however, their findings are not directly comparable. Differences in study design, geographic context, exposure metrics and accident indicators result in highly inconsistent estimates. As a result, current evidence does not support the definition of robust, sector-specific thresholds linking temperature increases to accident risk in construction. This lack of comparability limits the possibility of establishing reliable quantitative benchmarks to guide preventive measures. It is worth noting that technological proposals aimed at early risk detection are beginning to emerge. In this regard, Min *et al*. (2025) evaluated pigments capable of changing colour in response to increases in body temperature. While heat remains the most extensively studied climatic factor, other analyses have examined rain, humidity, wind, and cold, confirming that these conditions also alter work environments and influence accident probability. However, scientific literature on these factors remains limited.

Beyond physical effects, the reviewed studies also highlight the significant psychosocial impact of climate change in the workplace. Research by Martin *et al*. (2025) shows that anxiety, perceived safety, and concern about workplace accidents strongly influence decision-making, affecting both procedures and the ability to assess risks accurately. Priolo *et al*. (2025) emphasize that subjective risk perception shapes preventive behaviour, particularly during workdays with adverse environmental conditions. This psychosocial dimension is further supported by the meta-analysis conducted by Man *et al*. (2025), which demonstrates that work-related stress caused by unfavourable environmental factors increases accident probability and reduces performance quality. These findings underscore the need to incorporate psychosocial factors into preventive management in the construction sector.

Table 1: *Summary of the studies included in the systematic review.*

Author(s)	**Year**	**Study type**	**Climate-related risk**	**Main findings**	**Preventive implications**
Abdul-Nabi *et al.*	2025	Scoping review	General climate change	Increasing environmental and health impacts since 2015	Integration of climate change into OHS policies
Acharya *et al.*	2018	Review	Heat stress	Heat exposure reduces capacity and raises risk	Heat-stress plans, hydration, training

Author(s)	**Year**	**Study type**	**Climate-related risk**	**Main findings**	**Preventive implications**
Habibi *et al*.	2025	Systematic review	Extreme heat	Association between thermal exposure and chronic kidney disease	Preventive medical monitoring for exposed workers
Han *et al*.	2024	Meta-analysis	Heat exposure	Heat reduces productivity and increases strain	Thermal-monitoring tools and adjusted work-rest cycles
Man *et al*.	2025	Meta-analysis	Occupational stress	Association between occupational stress and OHS outcomes	Integration of psychosocial factors
Martin *et al*.	2025	Structural model (PLS-SEM)	Risk perception	Influence of emotional factors on safety decision-making	Training in safety culture and risk management
Min *et al*.	2025	Applied studies	Thermal stress	Development of technological monitoring solutions	Technological innovation for thermal-risk prevention
Pomeroy & Pilbeam	2025	Qualitative study	Safety metrics	Differences in the interpretation of safety indicators	Improvement of preventive assessment systems
Priolo *et al*.	2025	Systematic review	Safety behaviours	Relationship between risk perception and preventive behaviors	Strengthening of safety culture
Rossi *et al*.	2025	Systematic review	Extreme temperatures	Association between extreme heat and increased risks among outdoor workers	Need for specific thermal-exposure protocols
Zhu *et al*.	2025	Experimental study (fNIRS)	Thermal stress	Significant reduction in attention under prolonged heat exposure	Adjustments to work shifts and thermal break schedules
Kjellstrom *et al*.	2016	Review and modelling study	Occupational heat exposure	Heat reduces work capacity and productivity	Heat-limits, work-rest cycles, climate-adapted planning
Xiang *et al*.	2014	Epidemiological study	Heatwaves and occupational health and safety	associated with increased risks of work-related illness and injury	Heatwave plans and work adjustments
EU-OSHA	2024	Institutional report	Climate-related occupational risks	One in three workers exposed: construction highly affected	Integrate climate risks into OHS; prioritise adaptation
ISO 45003	2021	International standard	Psychosocial risks in work environments	Framework for managing psychosocial risks	Incorporate psychosocial risk management into OHS

In this context, ISO 45003:2021 (2021) becomes particularly relevant, as it provides guidelines for managing psychological risks at work—guidelines that are especially valuable in construction, where climatic conditions, as shown, increase mental workload and hinder safe and effective decision-making.

Regarding preventive measures, the studies analysed in this systematic review consistently emphasize the need to incorporate climate adaptation strategies. Among the most frequently cited measures are rescheduling work to avoid the hottest hours of the day, implementing frequent

breaks in shaded areas, promoting worker hydration, and strengthening the use of environmental monitoring systems. These recommendations are reinforced by the EU-OSHA (2024) report, which states that regular exposure to adverse climatic conditions affects one in three European workers, with the construction sector identified as one of the most impacted.

Furthermore, Kjellstrom *et al*. (2016) and the International Labour Organization (ILO, 2019) highlight that, although some countries have begun adapting their preventive systems, the lack of standardized guidelines and sector-specific strategies negatively affects the effectiveness of preventive responses. Studies by Xiang *et al*. (2014) and Acharya *et al*. (2018) support the idea that adjustments in work pace, thermal monitoring, and preventive education in the sector can be effective. They also underscore the potential of digital tools, such as mobile applications for thermal tracking (Han *et al*., 2024), which may offer promising solutions for prevention.

However, despite the progress discussed, this review identifies significant gaps. First, most analyses focus on a single factor (heat) leaving other meteorological phenomena largely understudied or entirely unexplored. Second, there is a notable lack of applied research specifically focused on construction sites in Southern European countries (such as Spain, Portugal, Italy and Greece) where the frequency and intensity of heatwaves and thermal-stress episodes have increased significantly in recent years and where the effects of climate change are more pronounced. Additionally, methodological heterogeneity among studies makes comparisons difficult, limiting the identification of consistent patterns. Finally, there is a scarcity of empirical evaluations that provide robust evidence on the effectiveness of implemented preventive measures.

The studies reviewed but not included in the main analysis (Nazneen *et al*., 2025; Habibi *et al*., 2024; Carolina & Wijaya, 2025; Ghaisani & Susilowati, 2025) reflect thematic and methodological dispersion on the subject. Although they offer interesting perspectives on support technologies, risk management, and cognitive assessments, their limited alignment with the objectives of this systematic review underscores the need to establish more homogeneous conceptual frameworks.

Conclusions

The findings show that climate change exacerbates both physical and psychosocial risks in the construction sector. Moreover, decision-making and preventive behaviour are significantly affected by these conditions. These results underscore the importance of moving toward an integrated approach that combines physical, organizational, technological, and psychosocial measures to ensure the progressive adaptation of prevention systems in construction sites.

Although climate-related hazards (particularly heat stress) clearly affect workers' health and performance, the evidence reviewed shows that the current scientific literature has not yet established a consistent or quantifiable link between climate change and specific accident typologies in construction. This gap reflects both the emerging nature of the field and the lack of studies that analyse accident mechanisms in relation to environmental variables.

Nevertheless, the findings of this review highlight the potential of adopting a climate-informed perspective in occupational risk prevention. The dynamic and outdoor-based characteristics of construction work suggest that environmental factors such as temperature, humidity, solar radiation, wind conditions or noise may interact with task demands, human performance and organisational constraints, influencing the likelihood and severity of accidents. Integrating these variables into preventive frameworks could therefore broaden the understanding of

accident causation in construction and support the development of more adaptive risk-management strategies.

Future research should focus on producing sector-specific quantitative models, improving the measurement of environmental exposure at task level and examining how climatic conditions interact with human, technical and organisational factors. Advancing this line of enquiry may help shape more resilient prevention systems capable of addressing the evolving challenges posed by climate change in construction environments.

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