Bulletin n°39

Veille thermique
Période : juillet 2026

Objectifs :

L'INRS est de plus en plus sollicité sur des questions concernant les activités en entreprise par forte chaleur : les activités en extérieur, l'été en période de canicule, mais aussi les activités en intérieur, dans des lieux aux conditions thermiques extrêmes. L'objectif de cette veille est de se tenir informé sur ces thématiques, dans une période où la problématique thermique croît avec les changements climatiques.

La bibliographie extraite de la base de données INRS-Biblio, permet la consultation des ressources en version PDF.

Les liens mentionnés dans le bulletin donnent accès aux documents sous réserve d'un abonnement à la ressource.

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS.

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EPI, matériaux protecteurs/réchauffants

K. Yamaguchi, S. Okamoto, A. Makino, R. Yabuuchi, O. Girard and K. Goto.

Short-term endurance training in the cold with layered clothing mitigates perceptual strain during exercise in the heat.

EUROPEAN JOURNAL OF APPLIED PHYSIOLOGY. 2026.

https://doi.org/10.1007/s00421-026-06319-1

Purpose We examined whether short-term endurance training in the cold combined with layered clothing enhances cardiovascular, thermoregulatory, and performance adaptations. Methods Sixteen healthy males completed five consecutive days of endurance cycling in the cold (10 degrees C, 50% relative humidity [rH]) while wearing either thermal layered clothing (WEAR) or light clothing (CON). Before and after training, participants performed a graded exercise test, a time-to-exhaustion test, and a heat stress test (30 min at 35 degrees C, 50% rH). Results During training, heart rate, skin temperature, and sweat rate were higher in WEAR than CON (P < 0.05). Maximal power output increased similarly in both groups (WEAR: + 7.2 +/- 9.5%; CON: + 8.4 +/- 7.1%, P < 0.05), while maximal oxygen uptake improved only in WEAR (52.4 +/- 7.3 to 55.2 +/- 7.1 mL/kg/min, P < 0.05). During the heat stress test, ratings of perceived exertion and thermal sensation decreased after training in WEAR only (P < 0.05), with no changes in sweat rate, skin temperature, or rectal temperature in either group. Conclusion Short-term endurance training in the cold combined with layered clothing attenuated perceptual strain during subsequent exercise in the heat, implying a practical alternative approach to traditional heat acclimation strategies.

J. Dai, H. T. Zhang, C. C. Han and Y. Ke.

Thermal Comfort and Energy Efficiency of Intermittently Heated Protective Clothing in Cold Conditions.

COATINGS. 2026;16(7).

https://doi.org/10.3390/coatings16070784

Balancing energy efficiency and wearer thermal comfort in cold environments remains a critical challenge for wearable heating systems. Commercial graphene-film heating pads, consisting of a graphene film sandwiched between cotton-gauze layers, provide a flexible heating platform; however, the effects of temporal power-modulation strategies on physiological responses, subjective thermal perception, and energy use remain insufficiently understood. Using identical heating elements and fixed heating locations, this study evaluated three intermittent heating strategies for electrically heated garments: (i) a descending-step protocol (IP-1), (ii) alternating dual-power heating (IP-2), and (iii) periodic ON/OFF cycling (IP-3). Ten healthy male participants completed five randomized experimental conditions, including continuous heating (CP) and no heating (NH), during 60 min of exposure at -5 degrees C. Mean skin and torso temperatures, together with subjective thermal sensation, comfort, and preference, were assessed. Compared with IP-3, IP-1 and IP-2 maintained significantly higher mean skin temperatures from 15 to 60 min (p < 0.05), while their subjective responses remained closer to thermal neutrality. CP produced the strongest local warming but resulted in excessive warmth in the directly heated torso regions, whereas IP-3 provided insufficient thermal compensation. IP-1 achieved the most favorable comfort-efficiency balance, maintaining torso warmth and acceptable subjective responses while reducing energy use by approximately 46% relative to CP. These findings indicate that

the transition characteristics and continuity of power delivery, rather than heating duration alone, are critical for optimizing thermal comfort and energy efficiency in wearable heating systems.

EPI, matériaux protecteurs/refroidissants

M. Kinoshita, T. Sakoi, Y. Horiba, C. S. Gao, M. Ishii, R. Kino, K. Kumagai and K. Oya.

Application of a progressive heat stress protocol to cooling clothing: The cooling effect of a liquid cooling vest.

ENERGY AND BUILDINGS. 2026;369.

https://doi.org/10.1016/j.enbuild.2026.117903

Cooling clothing is a personal cooling system that only cools the microclimate around an individual, alleviating heat stress. This study used a progressive heat stress protocol (PHSP) to evaluate the cooling effectiveness of a liquid cooling vest (LCV), a type of cooling clothing. Through the PHSP, the upper-limit thermal environment for the physiological prescriptive zone was determined for both normal work clothes and the LCV. The clothing effect was evaluated based on this difference. The PHSP gradually increased the operative temperature until the body's thermal equilibrium collapsed, thus evaluating the upper operative temperature limit (Tup). The experiments were conducted at relative humidities of 40% (R4) and 80% (R8), comparing the LCV condition (LCVC) with the normal work clothes condition (NWCC). The results indicated that LCVC significantly increased Tup from 37.9 f 1.6 degrees C to 41.0 f 2.5 degrees C in R4 and from 31.5 f 1.0 degrees C to 34.9 f 2.5 degrees C in R8. Using body heat balance equations, the cooling flux was calculated to be 475 W/m2, with sensible and evaporative heat transfer coefficients of 11.0 W/(degrees C center dot m2) and 58.8 W/(kPa center dot m2), respectively. Considerable variability was observed in the Tup of the LCVC compared with that of the NWCC. The variability was attributed to the decreased reproducibility of the minute spatial presence and a large temperature gradient within the LCV, worn in close contact with a small body area. These findings suggest that the PHSP is an effective method for comparing the cooling effects and evaluating the characteristics of cooling clothing.

C. Bensalem, A. Benarous and P. O. Logerais.

Thermal and skin injury analysis on firefighter's body-clothing assembly.

ENGINEERING RESEARCH EXPRESS. 2026;8(14).

https://doi.org/10.1088/2631-8695/ae8e39

During rescue actions, firefighters can be exposed to multiple fire conditions, including flashovers and back-drafts. Accordingly, the performance of the protective clothing are the key demand for any fire safety strategy and fabrics developments. In this context, several unexpected burn injuries were noted on firefighters' bodies, despite the consistency of the protective clothing. Developing thermophysical models for the clothing-skin interaction is considered a mandatory step to enhance the current understanding of the firefighting domain. The present study is an attempt to predict the temporal evolution of the temperature and the skin injury thresholds within the body-clothing assembly. The proposed model is based on an algebraic formulation with a heat transfer balance accounting for radiation-convection-conduction on each fabric and skin layer. The numerical results illustrate the temporal evolution of the temperature at the clothing-skin layers, as well as the exposure time before the first- and the second-degree burns. The results exhibit quite well agreements with literature findings, thereby validating the adequacy of the model .

V. Kumar and D. Bhanja.

Thermal performance analysis of firefighter protective clothing under coupled convective-radiative exposure: Effects of fabric reflectivity, airflow, and heat transfer intensity.

INTERNATIONAL COMMUNICATIONS IN HEAT AND MASS TRANSFER. 2026;178.

https://doi.org/10.1016/j.icheatmasstransfer.2026.111935

This study investigates the influence of fabric reflectivity, firefighter age, exposure type, and airflow conditions on the thermal protective performance of firefighter clothing under flame, combined convective-radiative, and radiative heat exposures. Results show that higher heat flux and airflow velocity significantly increase peak skin temperatures, stored thermal energy, and thermal risk, while greater fabric reflectivity reduces temperature rise and delays thermal damage across all exposure conditions. For the same exposure intensity, enhanced reflectivity decreases substrate-layer temperature by up to 3.92 degrees C in flame exposure, 1.85 degrees C in mixed exposure, and 4.38 degrees C in radiative exposure. Older firefighters experience higher interface temperatures and earlier onset of seconddegree burns compared to younger age groups. Increasing fabric reflectivity improves thermal protection and safety performance, achieving maximum safety enhancements of 11.4% under combined exposure and 17.5% under radiative exposure. Additionally, higher convective heat transfer coefficients increase stored energy and slow cooling, indicating greater thermal stress. The findings highlight the importance of optimizing reflective protective clothing based on firefighter age and exposure conditions to improve thermal safety and reduce burn injury risk.

Maladies liées à la chaleur

M. Ali, W. Mayberry, R. Achey, J. Putaala and A. Nouh.

Environmental Exposures and Stroke Risk: Converging Pathways, Unequal Burdens, and Prevention Opportunities.

CURRENT NEUROLOGY AND NEUROSCIENCE REPORTS. 2026;26(1).

https://doi.org/10.1007/s11910-026-01505-2

Purpose of Review To synthesize recent evidence on how environmental exposures influence stroke risk, with emphasis on air pollution, thermal stress, circadian and occupational disruption, built and social environments, and selected toxicants.Recent Findings Long-term and episodic air pollution, especially fine particulate matter with aerodynamic diameter <= 2.5 mu m (PM2.(5)) and wildfire smoke, remain most consistently associated with stroke risk. Extreme heat combined with heat-humidity metrics is emerging as an important acute stroke trigger. Noise, artificial light at night, shift work, and long working hours show smaller but plausible associations, while greener and more walkable environments may be modestly protective. Social and structural disadvantage clusters, multiple exposures and inequities play an integrated role in risk and prevention.Summary Environmental determinants are increasingly relevant to stroke risk. The strongest current links are realted to pollution, heat, sleep, and work disruption, as well as environmental inequity. Future research should move beyond single-exposure models toward combined-exposure as well as intervention-focused approaches.

N. D. Kien, N. H. D. My, P. T. Dung, T. K. Phong, T. T. C. Tri, D. T. A. Thu and B. D. The.

Exploring the Relationship Between Individuals' Coping Measures and the Economic Burden of Heat-related Illnesses: Insights from Central Vietnam.

JOURNAL OF HEALTH MANAGEMENT. 2026.

https://doi.org/10.1177/09720634261466388

Heat-related stress has emerged as a pressing public health concern worldwide with significant socio-economic implications. This study focused on Vietnam, a tropical country that is highly vulnerable to extreme heat events, to investigate the interplay between individuals' coping measures and the economic burden associated with heat-related illnesses. Employing a two-stage estimation approach, we identified influential factors that shape individuals' choices regarding coping measures and estimated the treatment effect associated with these decisions. Our findings highlight the significance of background diseases, heat exposure in working conditions, perceived effectiveness of available coping measures, gender and educational attainment of household heads as key determinants of the adoption of coping measures. Furthermore, we demonstrated that pre-existing health conditions, age and a longer duration of exposure influence the economic burden of heat-related illnesses. The results reveal that the effective implementation of both individual and combined coping measures substantially reduces this burden, with multiple measures exhibiting a greater impact than single measures alone. These findings offer valuable insights into policymakers and healthcare providers, enabling them to develop interventions that promote the adoption of coping measures and mitigate the economic consequences of heat-related stress.

P. Huang, Z. J. Rao, S. J. Liu, C. Y. Qu, X. Geng, J. H. Zhang, D. R. Gao, D. Z. Wu, Q. M. Wei and J. X. Zhao.

Heat Acclimation Training Attenuates Oxidative Stress and Improves Mitochondrial Function to Protect the Heart from Exertional Heat Stroke in Mice.

MEDICINE & SCIENCE IN SPORTS & EXERCISE. 2026;58(7):1449-63.

https://doi.org/10.1249/MSS.0000000000003971

HUANG, P., Z. RAO, S. LIU, C. QU, X. GENG, J. ZHANG, D. GAO, D. WU, Q. WEI, and J. ZHAO. Heat Acclimation Training Attenuates Oxidative Stress and Improves Mitochondrial Function to Protect the Heart from Exertional Heat Stroke in Mice. Med. Sci. Sports Exerc., Vol. 58, No. 7, pp. 1449-1463, 2026.Introduction:Exertional heat stroke (EHS) leads to cardiac structural damage and functional impairment. Heat acclimation (HA) training may serve as an effective strategy to prevent and mitigate such damage, yet the underlying molecular and cellular alterations remain unclear.Methods:A C57BL/6N mouse model was used to study EHS-induced myocardial injury and evaluate the cardioprotective effects and mechanisms of HA training. Cardiac injury was assessed via plasma biomarkers, echocardiography, and histopathology, and transcriptomic analysis revealed links among injury, oxidative stress, and mitochondrial alterations. Transmission electron microscopy, O2K respirometry, and redox measurements further elucidated the mechanisms underlying mitochondrial structural and functional changes.Results:EHS was associated with structural damage to myocardial tissue, including myocardial fibrosis, pathological echocardiographic changes, and a substantial elevation of the myocardial injury biomarker (cardiac troponin I). Mitochondrial structural disruption, impaired respiratory capacity, decreased adenosine triphosphate production, and disrupted redox balance were identified as potential contributors to these pathological changes. HA training was associated with attenuated EHS-induced myocardial damage, as evidenced by the amelioration of cardiac dysfunction and histopathological alterations, mitigation of mitochondrial structural damage, restoration of mitochondrial function, and increase in antioxidant capacity. Furthermore, HA training enhanced the thermoregulatory capacity and aerobic endurance of mice under high-temperature conditions. Transcriptomic analysis revealed that biological processes and signaling pathways enriched in differentially expressed genes with mitochondrial dysfunction and oxidative stress.Conclusions:This work identifies transcriptional alterations and signaling pathways associated with EHS-induced myocardial injury, suggesting pivotal roles for mitochondrial dysfunction and oxidative stress. Additionally, this research provides a theoretical basis and potential intervention targets for the prevention and mitigation of heat stress-induced cardiovascular damage through HA training.

Outils et capteurs de mesure

J. Jia, J. L. Wu, M. Y. Miao, M. Xu, Z. B. Deng, J. X. Zheng, S. L. Xie, J. L. He and J. Xu.

A highly sensitivity temperature sensor based using Ti3C2Tx@Cu3(BTC)2 composite material allows accurate monitoring of human body temperature.

MATERIALS CHEMISTRY AND PHYSICS. 2026;359.

https://doi.org/10.1016/j.matchemphys.2026.132539

With the rapid development of smart wearable devices, the performance requirements for flexible temperature sensors are constantly increasing. However, traditional temperature-sensitive materials have problems such as insufficient flexibility, sensitivity and stability. Although emerging MXene materials have excellent electrical conductivity and flexibility, they inherently have the defects of interlayer delamination and poor durability, which are difficult to meet the practical application requirements. To address the aforementioned challenges, this paper proposes a material system that combines MXene with metal-organic frameworks (MOFs), leveraging the synergistic effects among components to break through the performance bottlenecks of a single material. In this study, Ti3C2Tx was used as the representative of MXene and Cu3(BTC)2 as the representative of MOF. The Ti3C2Tx@Cu3(BTC)2 composite material was prepared by in-situ synthesis method. The influence of the composite ratio of Ti3C2Tx to Cu (CO2CH3)2 center dot H2O mass ratio within the range of 1:0.25 to 1:1 on the structure and properties of the material was systematically exploredCharacterisation was conducted using scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), Xray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS). Finally, the temperature sensing performance test was carried out on the pre-treated cotton fabric. The characterization results confirm that at high proportions, the composite material can form a dense nanoparticle coating layer on the Ti3C2Tx substrate. Moreover, this flexible functional material exhibits a gradient structural evolution feature. Ti3C2Tx acts as a conductive interlayer to anchor the Cu3(BTC)2 particles, thereby optimizing the chemical properties of the material's surface. The characterization results confirm that the composite materials can form dense nano-performance on the Ti3C2Tx substrate at a high proportion. The test shows that the sensor with the optimal composite ratio CHTH-2 (mass ratio Ti3C2Tx: Cu (CO2CH3)2 & sdot;H2O = 1:0.5)exhibits a high temperature sensitivity coefficient of-1.20499 %/oC within the range of 25-60 degrees C, with a linear correlation of 0.97 and a dynamic range of Delta R/R0 reaching 35%. Measurements of wrist temperature revealed that a 1 degrees C increase in sensor temperature resulted in an approximately 1.8% reduction in resistance. This study successfully developed an excellent flexible temperature-sensitive material system, providing new material options and technical support for the research and development of highly sensitive wearable temperature sensors.

B. H. Sang, S. Oh, L. Kim and S. W. Ahn.

Non-Axillary Chest Skin Temperature Underestimates Core Temperature During Redistribution Hypothermia Following Spinal Anesthesia.

THERAPEUTIC HYPOTHERMIA AND TEMPERATURE MANAGEMENT. 2026.

https://doi.org/10.1177/21537658261468177

Accurate temperature monitoring is essential for detecting perioperative hypothermia during spinal anesthesia, where rapid redistribution of body heat commonly occurs. Although zero-heat-flux (ZHF) thermometry has emerged as a noninvasive method for estimating core temperature, the reliability of

chest skin temperature monitoring in this context remains unclear. In this prospective observational study, temperature measurements were obtained at 5-minute intervals using a forehead ZHF sensor, an infrared tympanic thermometer, and a non-axillary chest skin probe in patients undergoing orthopedic surgery under spinal anesthesia. Agreement between methods was evaluated using Bland-Altman analysis for repeated measurements, the proportion of paired measurements within +/- 0.5 degrees C, and Lin's concordance correlation coefficient. Ninety-nine patients completed the study. ZHF and tympanic temperatures showed good agreement, with a mean difference of 0.04 +/- 0.35 degrees C, limits of agreement from -0.63 degrees C to 0.72 degrees C, and 89% of paired measurements within +/- 0.5 degrees C. In contrast, chest skin temperature demonstrated poor agreement with both ZHF and tympanic measurements. The mean difference between ZHF and chest skin temperature was 0.99 +/- 1.11 degrees C, with wide limits of agreement (-1.18 degrees C to 3.17 degrees C), and no measurements met the predefined +/- 0.5 degrees C threshold. Similar discrepancies were observed when chest skin temperature was compared directly with tympanic temperature. These findings indicate that non-axillary chest skin temperature does not reliably reflect core temperature during redistribution hypothermia under spinal anesthesia and should not be used as a surrogate. ZHF thermometry showed substantially better agreement with tympanic temperature and may provide a more reliable noninvasive alternative for perioperative temperature monitoring.

A. M. Winkler, A. R. Moore and W. R. Kinnaird.

Physiological Recovery Following Repeated Firefighting Work in Recruit Firefighters.

FIRE-SWITZERLAND. 2026;9(7).

https://doi.org/10.3390/fire9070306

Firefighters often perform multiple consecutive bouts of high-intensity work in hot environments, which can lead to physiological fatigue and increased health risks. This study examined changes in core temperature, skin temperature, and heart rate during recovery periods following repeated bouts of work in recruit firefighters (n = 10) across a full day of outdoor training. Participants completed four work-rest cycles consisting of firefighting drills performed in full personal protective equipment (PPE), followed by passive recovery after PPE removal. Physiological measurements were recorded one minute prior to recovery and then at 5, 10, and 20 min throughout recovery. Skin temperature and heart rate decreased significantly ($p < 0.05$) within 5-10 min of recovery in most rounds. However, core temperature required at least 20 min to significantly decline ($p < 0.05$). These findings suggest that shorter recovery periods may be sufficient for heart rate and skin temperature to return to baseline, whereas longer recovery periods are needed for heat to dissipate from the core, especially as work intensity increases. Thus, standard rehabilitation protocols may be insufficient under more extreme working conditions and should be adjusted accordingly to ensure firefighter safety.

Travail par fortes chaleurs et périodes de canicule

R. Lionar, L. J. Wang, T. Parkinson, J. Kim and R. De Dear.

Development of a predictive indoor clothing insulation model for Sydney.

ARCHITECTURAL SCIENCE REVIEW. 2026.

https://doi.org/10.1080/00038628.2026.2695219

Clothing insulation is a key input to thermal comfort models such as the Predicted Mean Vote, yet office attire insulation values are typically based on rough seasonal estimates. This paper develops a locally relevant clothing database for Sydney office buildings and a predictive clothing insulation model based on outdoor temperature forecasts, using longitudinal data from an air-conditioned finance-sector office. Gender significantly influenced clothing choices ($p < 0.001$), though corporate dress codes and seasonal weather often override gendered thermal preferences. The analysis of 185 days of data showed that forecasted daily maximum outdoor temperature, combined with gender, dress code, and season, provided the highest explanatory power (adjusted R-2 = 0.414), with observed daily average temperature as a viable alternative (adjusted R-2 = 0.408). Cross-validation yielded a mean RMSE of 0.089 clo and MAE of 0.072 clo. The model offers a calibrated alternative to static ASHRAE 55 estimates for Sydney offices.

R. Srivastava.

Enhancing Indian worker resilience through legal reform and integration of international occupational heat stress guidance.

DISCOVER PUBLIC HEALTH. 2026;23(1).

https://doi.org/10.1186/s12982-026-02553-2

The rising temperatures and corresponding intensified heatwaves have become a critical occupational health threat for many parts of the world, including India. The Indian situation becomes even more alarming, considering the vulnerability in terms of a vast informal and outdoor workforce that is regularly disproportionately exposed to hazardous thermal conditions. This study examines the scale of occupational heat exposure and identifies significant lacunas within the Occupational Safety, Health and Working Conditions (OSH) Code, 2020. This study reviews secondary data, including historical climate information and international frameworks. The recent development in the form of the ground-breaking WHO-WMO 2025 technical report is reviewed to analyse the impact of unmanaged heat stress on health and economic activities. The findings from these reviews indicate that a large number of Indian workers, of the order of more than 380 million, face extreme heat stress, leading to health impacts in the form of chronic kidney diseases, productivity declines and a projected loss of 34 million jobs by 2030. The OSH code in the current form fails to provide explicit protection against these unmanaged heat stress conditions and also undermines the different kinds of risks associated with them. These shortcomings in the OSH code are addressed by proposing comprehensive legislative reforms and corrective measures. These measures include integrating the India Meteorological Department's (IMD) impact-based heat wave alerts into the planning of workplace procedures and adoption of globally recognised and regionally tailored principles. The study concludes that customised & enforceable heat action plans with inclusive policy measures are critical to protect workers' health, sustain nations' productivity, thereby ultimately promoting the equitable climate resilience in an increasingly warming world.

F. Ji, W. M. Liang and Z. N. Pei.

Extreme heat in the workplace: Catalyst or barrier to safety management?

ECONOMIC ANALYSIS AND POLICY. 2026;92:484-97.

https://doi.org/10.1016/j.eap.2026.06.009

Extreme weather profoundly influences the resource allocation and operational decisions of micro-economic agents. Using data from Chinese A-share listed companies between 2011 and 2021, combined with meteorological records from the US National Centers for Environmental Information, this study shows a significant decline in occupational health and safety management system implementation among enterprises exposed to extreme heat. Mechanism analysis indicates that this decline is primarily driven by heightened financing constraints and rising labor costs caused by extreme heat. Further investigation shows that the inhibitory effect of extreme heat on occupational health and safety management system implementation is particularly pronounced among non-state-owned enterprises, manufacturing firms, companies with low-quality social responsibility disclosures, and those operating in regions with weak labor protection capacity. In addition, the findings demonstrate that extreme heat simultaneously diminishes the quality of corporate human resources and internal cash flows, further underscoring its threat to sustainable enterprise development.

S. T. Scheidl, I. Kaspar-Ott and E. Hertig.

Occupational heat stress in hospital settings: a combined assessment of staff perceptions and indoor climate to support heat action planning.

BMC PUBLIC HEALTH. 2026;26(1).

https://doi.org/10.1186/s12889-026-28452-4

Background and aims Occupational heat stress in healthcare settings is an emerging public health concern, yet evidence on indoor heat exposure and perception in hospitals remains limited. This study assessed perceived occupational heat stress among hospital employees by integrating staff-reported heat perceptions with indoor temperature measurements to identify associations between perceived heat stress, workplace characteristics, preventive behaviors, heat-related knowledge, and indoor thermal conditions. Methods A cross-sectional study was conducted at a large tertiary care hospital in southern Germany. An anonymous online survey collected data on heat perception, heat-related symptoms, work impairment, preventive behaviors, knowledge, training and heat warning practices among hospital employees. Multiple survey items resulted in a perceived occupational heat stress index (POHSI). Indoor air temperature was measured continuously during the summer periods 2024 and 2025 using calibrated sensor loggers placed in staff rooms across the hospital. Associations between POHSI, workplace factors, preventive measures, and environmental conditions were analyzed descriptively and inferentially. Results A total of 681 employees participated. 38.7% of the participants scored high or very high POHSI. Frequently reported symptoms included fatigue, concentration difficulties, and dizziness, accompanied by reduced work performance. Higher POHSIs were observed among physically active staff and clustered spatially in upper floors with elevated indoor temperatures. Lower levels of heat-related knowledge and training were associated with higher POHSIs (ANOVA: F = 15.33, p < 0.001; Kruskal-Wallis: chi & sup2; = 54.05, p < 0.001) with moderate effect sizes (eta & sup2; approximate to 0.09). While some individual preventive measures were associated with lower POHSI, participants predominantly requested structural and organizational interventions. Subjective heat perceptions corresponded closely with measured indoor temperature patterns. Conclusion Occupational heat stress represents a relevant indoor environmental and occupational health challenge in hospital settings. The combination of subjective and objective indicators enabled the identification of heat-vulnerable work

environments and associated workplace, knowledge-related, and environmental factors. The findings further indicate that individual coping strategies alone may be insufficient under sustained indoor heat exposure and support the development of hospital-specific heat prevention and adaptation strategies.

R. Akbari, M. Asghari, M. Amrolahi, A. H. Nataj and S. E. Samaei.

Validity and field applicability of the environmental stress index (ESI) for heat stress assessment in outdoor workers of arid/semi-arid climates.

INTERNATIONAL JOURNAL OF BIOMETEOROLOGY. 2026;70(8).

https://doi.org/10.1007/s00484-026-03282-6

The Wet-Bulb Globe Temperature (WBGT) is the benchmark for occupational heat-stress assessment, yet its accuracy can be constrained by variability in humidity, air movement, and solar load. The Environmental Stress Index (ESI), derived from routinely available meteorological variables, has been proposed as a low-cost field surrogate. This study evaluated the agreement and physiological relevance of ESI versus WBGT among outdoor workers across arid and semi-arid climates in Iran. A cross-sectional study was conducted on 150 sand-and-gravel mine workers in arid and semi-arid regions of Iran. Environmental and physiological data were collected at different times. The WBGT (based on ISO 7243) and ESI (based on ambient parameters) were calculated. Between-climate differences were analyzed using t-test or Mann-Whitney U; agreement was assessed by ICC; and associations with meteorological and physiological variables were evaluated using GEE (alpha = 0.05). In the semi-arid site, the values of both WBGT and ESI were higher during the warmer hours ($p < 0.001$). Regression analyses revealed statistically significant relationships between the thermal indices and most environmental parameters in both climates ($p < 0.05$). The agreement between WBGT and ESI was high (ICCarid:0.98, ICCsemi-arid:0.97) with statistically significant correlations in both climates ($p < 0.001$). In the arid site, both WBGT and ESI showed significant positive correlations with physiological responses, whereas in the semi-arid site, only the ESI index exhibited significant correlations with physiological responses ($p < 0.05$). Overall, ESI demonstrated performance equivalent to WBGT in the arid site and was suitable for field screening applications. ESI shows strong agreement with WBGT and meaningful physiological validity in arid sites, making it a viable low-cost screening tool when WBGT devices are unavailable. It is recommended that industries in arid regions adopt ESI for daily heat-stress monitoring.

A. Ghimire.

Who Pays the Heat Debt? Ethics, Labour, and Governance in a Warming World.

BIOETHICS. 2026.

https://doi.org/10.1111/bioe.70162

Extreme heat is emerging as one of the most consequential occupational hazards of the 21st century. More than 2.4 billion workers, over 70% of the global labour force, are exposed to excessive heat, with more than 22 million heat-related occupational injuries and nearly 19,000 deaths each year. By 2030, heat stress is projected to reduce global working hours by 2.2%, equivalent to 80 million full-time jobs, with the heaviest losses concentrated in low- and lower-middle-income countries. This paper argues that these figures disclose not only a climate and labour crisis, but also a problem of health justice. To conceptualise this, the article develops the framework of 'heat debt' to articulate the physiological, economic, and temporal burdens disproportionately imposed on workers to sustain global production, supply chains, and essential services in a warming world. Synthesising evidence from agriculture, construction, garment manufacturing, informal urban labour, and healthcare, this paper demonstrates

that this debt is systematically offloaded onto low-wage, migrant, informal, and feminised workforces. The analysis proceeds in three parts. First, it argues that excessive occupational heat must be analysed through the lenses of distributive and reparative justice. Second, it demonstrates how current labour law, climate policy, and corporate supply chain governance institutionalise thermal inequality. Third, it interrogates health systems in their dual capacity: as primary responders to heat-related morbidity, and as occupational environments that actively reproduce heat vulnerability among clinical staff. The article concludes by advancing a bioethical mandate of 'cooling as care,' positing that occupational thermal protection is an indispensable prerequisite for climate justice, decent work, and ethically defensible healthcare delivery.

S. Genç, S. Karakaya, S. S. Olcay, M. Kadioglu and I. C. D. Ütükler.

Working in Extreme Heat, an Invisible Occupational Risk: Legislation, Risk Management and Policy Recommendations for Türkiye: Turkish Thoracic Society Workshop Report on the Regulation of Working Conditions in Extreme Heat.

THORACIC RESEARCH AND PRACTICE. 2026;27(4):250-60.

https://doi.org/10.4274/ThoracResPract.2026.2026-2-5

Extreme heat, amplified by climate change, has become a predictable and escalating occupational hazard in T & uuml;rkiye, increasing the burden of heat-related illnesses, traumatic workplace injuries, and productivity losses among both outdoor and indoor workers, particularly in labor-intensive sectors and among vulnerable populations. This Turkish Thoracic Society workshop report synthesizes interdisciplinary expert input and available evidence to propose a practical, prevention-focused framework for regulating working conditions in extreme temperatures. The recommendations were systematically developed through four thematic interdisciplinary working groups and finalized by plenary consensus. Key recommendations include explicitly defining employers' duties to assess, prevent, and manage extreme weather-related risks within Occupational Health and Safety Law No. 6331; establishing secondary regulations that operationalize temperature/Wet-Bulb Globe Temperature (WBGT)-triggered work-rest schedules, hydration and cooling requirements, and acclimatization protocols; and standardizing objective heat-stress monitoring using the WBGT index (aligned with ISO 7243). The report prioritizes engineering and administrative controls (shading, ventilation/cooling, shift adjustments, rest areas, and "buddy systems") over reliance on personal protective equipment, and calls for strengthened labor inspection capacity "through the lens of climate change." Additional policy actions include integrating heat-related outcomes into occupational disease and injury surveillance systems, enhancing inter-institutional coordination for rapid reporting and work-stoppage mechanisms during extreme heat events, and implementing multilingual, sector-specific training and emergency preparedness pathways. Protecting informal and migrant workers, seasonal agricultural laborers, and individuals with chronic cardiopulmonary disease is highlighted as a core priority for equity and climate justice.

Actualités juillet 2026

- **Travail par fortes chaleurs et périodes de canicule**

Canicule : la chaleur transforme tous les métiers en profondeur, de l'agriculture à l'enseignement. Lemonde.fr, 2 juillet 2026

Aller à la déchetterie avant de commencer le travail ? Merci aux aménagements horaires imposés par la canicule au Mans. Actu.fr, 6 juillet 2026

« Je suis tout transpirant » : à Quimper, les artisans adaptent leurs horaires de travail à cause de la canicule. Ici.fr, 7 juillet 2026

Canicule et santé au travail : quelles sont les adaptations mises en place par les organisations ? Theconversation.com, 8 juillet 2026

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