Bulletin n°30

Veille thermique
Période : septembre 2025

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.

Sommaire :

EPI, matériaux protecteurs/refroidissants

Ambiance thermique chaude

T. Trisnadewi, S. Astriani, A. Kismanto, P. Zuldian, N. K. Supriatna, R. I. Purawiardi, O. Fariza, F. J. Ermada, N. Putra and N. Aprianti.

Energy storage performance of carbon black-enhanced coconut oil as a phase change material for heatstroke prevention in the CoolTis vest.

THERMAL SCIENCE AND ENGINEERING PROGRESS. 2025;65.

https://doi.org/10.1016/j.tsep.2025.103952

Heatstroke remains a significant occupational health risk for individuals working in hot environments, particularly during physically demanding tasks. To address this challenge, this study introduces the CoolTis Vest, a passive wearable cooling system that utilizes coconut oil-based phase change material (PCM) enhanced with carbon black derived from carbonized empty oil palm bunches. This sustainable approach not only repurposes agricultural waste but also improves PCM thermal stability and durability. Carbon black was added at concentrations of 0.1, 0.5, and 1 wt% through magnetic stirring, and the composite PCM was characterized using SEMEDS, elemental analysis, and differential scanning calorimetry (DSC). SEM-EDS revealed porous, sheet-like carbon structures enhancing PCM retention, while elemental analysis confirmed high carbon content (78.6-96.5 %) with surface oxidation. The formulation containing 0.5 wt% carbon black exhibited the most balanced thermal performance, with only an 8.5 % reduction in latent heat during heating and a notable 11.4 % increase during cooling. DSC analysis also showed a slight increase in melting temperature to 21.0 degrees C with stable cycling performance. Cooling trials conducted under simulated use conditions demonstrated effective cooling for up to 3.5 h, suitable for applications such as reactor maintenance or outdoor industrial work. These findings highlight the potential of carbon black-enhanced coconut oil PCM as a cost-effective and sustainable solution for wearable cooling technologies in extreme tropical heat conditions.

J. Li, Y. Y. Wang, L. Shao, L. He and J. Li.

Quantifying security ratings for firefighting protective clothing wearers within the human body-clothing-environment system.

TEXTILE RESEARCH JOURNAL. 2025.

https://doi.org/10.1177/00405175251356680

A timely and comprehensive evaluation of human thermal safety is critical for reducing the risk of accidents during fire emergency response operations. Previous studies on thermal safety assessment have primarily considered physiological factors but overlooked environmental factors or personal protective equipment. Here, we propose a multilevel early warning assessment framework based on the human body-clothing-environment interaction system using catastrophe theory. First, the catastrophe progression method was used to construct an evaluation index system for thermal safety from three dimensions: physiological factors (core temperature, skin temperature, heart rate, systolic blood pressure), clothing factors (thermal resistance, evaporative resistance), and environmental factors (temperature, relative humidity, and noise). Second, weights were determined using the entropy weight method and range analysis. Next, we established a five-level thermal safety classification system (level I-V: no, light, medium, serious, and critical warning) based on catastrophe

theory, representing risk gradients from negligible to critical conditions. Quantitative safety ratings were then obtained using multilevel catastrophe progression judgment. To validate the method, nine experimental scenarios representing varying firefighting conditions were tested for human thermal safety assessment. The results showed that the application of catastrophe models revealed critical thresholds where small parameter changes triggered abrupt shifts in human thermal safety, with the swallowtail model proving effective for analyzing system stability. This method provided a comprehensive assessment of thermal safety ratings in firefighters, with risk levels varying substantially across experimental scenarios and identifying high-risk conditions. This approach can provide timely warnings of thermal strain and improve risk-based decision-making for appropriate preventive practices.

F. H. Irawan, F. Fahma, L. Suryanegara, K. Syamsu, R. Purnawati, I. A. Dewi and A. Firmanda.

Sustainable smart textiles for personal self-cooling and heating cloth: review.

POLYMER BULLETIN. 2025;82(17):11697-738.

https://doi.org/10.1007/s00289-025-06014-9

The escalating climate crisis, driven by global warming, has resulted in extreme temperature instability. This phenomenon poses significant challenges to various human activities, including household, office, and industrial activities. Heating, ventilation, and air-conditioning (HVAC) systems are crucial in maintaining comfortable indoor environments. However, the energy consumption associated with these systems, often characterized by inefficiencies, contributes to greenhouse gas emissions, further exacerbating global warming. The global quest for energy efficiency demands innovative solutions to reduce reliance on centralized HVAC systems, which are major contributors to energy consumption and environmental burdens. Traditionally, clothing has served as a body covering, but advancements in material science are transforming textiles into intelligent partners for human comfort. Recent progress has focused on self-regulating textiles with cooling, heating, and dual-mode (cooling-heating) features that operate without external energy input. Radiative thermal mechanisms account for More than 65% of human body heat dissipation and are essential for thermal comfort. This review examines recent advancements in composite structures and polymer-metal/inorganic hybrid materials developed for radiative thermal regulation in textiles. It also highlights the potential of bio-based resources, such as lignocellulose, as sustainable alternatives to conventional synthetic fibers like polyester and thermoplastic polymers, an aspect that remains underexplored in previous reviews. In addition, the article examines fundamental mechanisms, fabrication approaches, and thermoregulation performance, while outlining the challenges and future opportunities of renewable-resource-based smart textiles as a foundation for further research.

J. C. Nie, L. Ding, T. Liu, D. L. Zhao, L. Wang, Y. R. Huang, Y. R. Chen and Q. Zhang.

Thermal resistance, evaporative and convective performance of protective clothing under coupled hypobaric and thermal stress: a thermal manikin experimental study.

THERMAL SCIENCE AND ENGINEERING PROGRESS. 2025;65.

https://doi.org/10.1016/j.tsep.2025.103910

This study establishes a novel methodology for evaluating protective clothing performance under combined high-altitude and temperature stressors, addressing critical gaps in standardized thermal characterization for aviation apparel. By integrating a pressure-adaptive forearm manikin prototype with a full-body Newton thermal manikin, we systematically quantified thermal resistance (R-ct),

evaporative resistance (R-et), and convective heat transfer coefficients (h(c)) across three temperatures (-9 degrees C, 20 degrees C, 34 degrees C) and two altitudes (0 m, 4000 m). Results revealed significant pressure-temperature interactions (p < 0.05) for R-ct and h(c), while R-et exhibited altitude insensitivity at 20 degrees C (p = 0.32). Notably, R-ct decreased by 0.15 m(2)<middle dot>degrees C/W from -9 degrees C to 20 degrees C at sea level but showed no significant variation at higher temperatures (20-34 degrees C, p = 0.09). Multivariate regression models demonstrated robust predictive capabilities, with adjusted R-2 values of 0.85 (h(c)), 0.76 (R-et), and 0.41 (R-ct), enabling rapid performance forecasting under documented operational profiles. The framework advances thermal science by resolving altitude-modulated convective and evaporative dynamics, offering direct applications in cockpit thermal management and adaptive garment design for extreme environments. This work bridges experimental and computational paradigms, reducing reliance on costly validation trials while enhancing predictive accuracy for multi-stressor scenarios in aerospace and occupational safety contexts.

Ambiance thermique froide

C. A. Barker, J. T. Power, A. Schnell and M. J. Mahar.

Evaluation of Indigenous garments and Government of Canada cold weather clothing insulation: growing Northern economies through safer personal protective equipment.

FACETS. 2025;10.

https://doi.org/10.1139/facets-2024-0100

The Arctic is one of the harshest environments due to remoteness and freezing temperatures, but Indigenous peoples have successfully persisted there for centuries through the development of protective garments. Limited research suggests that Indigenous-made garments provide excellent insulation. Contributing to this research, the insulation of Indigenous-made garments was measured using a thermal manikin, alongside issued clothing. Complimenting this laboratory work, Indigenous craft producers, Canadian Rangers, Coast Guard Auxiliary, and Government of Canada employees were interviewed and surveyed. It was found that some Indigenous-made garments had similar levels of insulation compared to issued clothing, while others were higher. Interview and surveys highlighted the benefits of Indigenous-made clothing. Interviewees almost universally supplemented their issued clothing to stay warmer, and want to support craft producers through purchasing products. Craft producers prefer using natural and traditional materials due to performance and longevity. Additionally, the act of creating their products has cultural significance with perceived positive mental health benefits. This foundational study demonstrated what Indigenous peoples have known for centuries: garments made with natural materials offer excellent protection, increasing safety in challenging conditions. Procurement of Indigenous-made clothing can increase the opportunities for craft producers, bolster Northern economies, and benefit employees in their work.

Maladies liées à la chaleur

D. H. Liu, X. Y. Tong, H. T. Wang and J. Yang.

An extended individualized two-node human thermal model for high-temperature environments.

INTERNATIONAL JOURNAL OF INDUSTRIAL ERGONOMICS. 2025;109.

https://doi.org/10.1016/j.ergon.2025.103792

The human thermal model offers significant utility and advantages in predicting human heat strain. An advanced two-node human thermal model was proposed based upon Gagge's foundational to simulate individual physiological responses in high-temperature settings. This enhanced model incorporates the impacts of elevated temperatures on metabolic rate and the convective coefficient, and it accounts for individual variations in body surface area, the set points of body temperatures, and skin blood flow. Additionally, adjustments were made to the parameters representing clothing thermal insulation and vapor resistance. eight Chinese youths-four males and four females-were exposed to a high-temperature environment (35 degrees C/50 % RH) while wearing two different types of clothing to replicate light and moderate intensity activities to validate the model. The findings indicate that the model excels in predicting the thermal responses of individuals under this experimental condition. The maximal discrepancies between simulated and observed values for core and skin temperatures were confined to 0.3 degrees C and 0.6 degrees C, respectively. The model has been preliminarily demonstrated to reliably forecast individual physiological responses in given high-temperature environments. Nevertheless, the current framework does not take into account water loss in the human body, which is a key factor in long-term heat exposure. Looking to the future, more thermal regulation parameters can be comprehensively considered, and verified under various working conditions, so as to predict the thermal strain of the human body in high-temperature environments more comprehensively.

K. Fukuzawa, K. Mori, K. Hashimoto, R. Tanaka, C. Nagano and S. Horie.

Ineffectiveness of Water Mist Spray to the Upper Body of Healthy Adults in Suppressing Core Temperature Under Windless Environment.

SAFETY AND HEALTH AT WORK. 2025;16(3):341-8.

https://doi.org/10.1016/j.shaw.2025.05.003

Background: Global warming has increased heat-related illness concerns. Water misting is used for workplace cooling, but its effect on core body temperature is unclear. Methods: We examined whether spraying water mist on the upper body suppresses the increase in core body temperature in hot and humid environments. Nine healthy adult men exercised for 60 min on a bicycle ergometer at four metabolic equivalents under two conditions: warm-humid environment (30 degrees C ambient temperature [Ta], 85% relative humidity [RH]) and hot-dry (HD) environment (40 degrees C Ta, 30% RH). Water mist (MIST) or no mist (CON) was applied to the back of the head, neck, and dorsum of hands every 10 min. Results: Rectal temperature changes were similar between conditions, but peak temperatures were slightly higher with MIST (38.32 degrees C vs. 38.14 degrees C, p = 0.074) in HD environments. The estimated sweat volume was lower with MIST, especially in HD settings. Conclusion: Water mist does not prevent core temperature increases and should be avoided in extremely hot environments.

Outils et capteurs de mesure

S. S. Bhuvad, R. Y. You and Q. Y. Chen.

Assessment of sustainable and accessible water-based cooling interventions during heat events through thermoregulation modeling.

BUILDING AND ENVIRONMENT. 2025;285.

https://doi.org/10.1016/j.buildenv.2025.113639

Extreme heat events pose a major threat to human health, particularly in regions with limited access to active cooling technologies. The escalating impacts of climate change have intensified the frequency, intensity, and duration of heatwaves, highlighting the urgent need for sustainable and accessible mitigation strategies. This study employed a modified JOS-3 thermoregulation model to evaluate the physiological effectiveness of three simple water-based cooling interventions-foot immersion, leg immersion, and dousing. The model incorporates dehydration, updated sensor signals, sweating, and modifications related to water immersion and dousing etc. Simulations were conducted using meteorological data from Indian cities representing hot-dry, warm-humid, and composite climate zones. Key parameters such as cooling method, water temperature, and extent of body surface cooling were varied. Among these cooling interventions, leg immersion with 20 degrees C water achieved the greatest reduction in core temperatureup to 0.7 degrees C,and delayed the onset of moderate hyperthermia compared to no cooling intervention. Meanwhile, foot immersion offered moderate relief, although its effectiveness declined under severe heat conditions. Dousing, particularly over larger body surface areas, effectively reduced core temperature. Furthermore, dousing also minimized thermal fluctuations in skin temperature compared to other water-cooling methods. Lower water temperatures in both leg and foot immersion further enhanced conductive heat loss, improving overall cooling performance. Overall, findings demonstrate that simple, passive cooling interventions can substantially alleviate physiological heat strain and serve as practical, sustainable strategies for vulnerable populations during extreme heat exposure. The study offers valuable insights into heat-health adaptation and public resilience planning in a warming climate.

S. Yu, X. J. Xie, Y. Guo and J. Z. Wang.

A CFD-based study on the heat transfer characteristics between the human body and the environment under low-temperature attire.

FRONTIERS IN BIOENGINEERING AND BIOTECHNOLOGY. 2025;13.

https://doi.org/10.3389/fbioe.2025.1583571

In order to study the interaction between the human body, clothing, and environment in a low-temperature environment, a three-dimensional human thermoregulation model was established based on real human body scanning images. The human body was divided into 12 parts by dividing the body into core, equivalent, skin, and clothing layers. Further computational fluid mechanics (CFD) numerical simulation was carried out to realize the measurement and calculation of human physiological parameters, such as human skin temperature, core temperature, and average temperature of the garment surface, in a low-temperature environment. The clothing surface heat transfer, clothing surface average temperature, human skin surface heat transfer, and local skin temperature change rule were explored with the external environmental temperature to establish a basis for the study of the human body's heat transfer characteristics in a low-temperature environment. To verify the accuracy of the developed numerical model of the human body, the simulated values of the human

body model were compared with the experimental measurements of the human local skin temperature and the simulated values in the literature. The results show that the maximum relative error between the local skin temperature of the human numerical model and the experimental measurements of the human body is 3.43%, and the human numerical model has a high degree of accuracy.

T. R. Razak, H. Jarimi, M. H. Ismail, M. S. M. Nadzir, E. Z. Ahmad, N. M. A. Rahman, M. H. Jamaludin, Y. H. Su and S. Riffat.

Data-driven thermal comfort modeling: Comparing AI-based predictions with PMV-PPD models.

ENERGY AND BUILDINGS. 2025;348.

https://doi.org/10.1016/j.enbuild.2025.116410

Accurate thermal comfort modeling is essential for optimizing energy-efficient, occupant-centric indoor environments. While widely used, traditional models such as Predicted Mean Vote (PMV) and Predicted Percentage Dissatisfied (PPD) often fail to capture individual variability in thermal perception and dynamic environmental changes. This study proposes a data-driven framework integrating objective environmental parameters (air temperature, mean radiant temperature, humidity, and air velocity) with subjective human responses (thermal sensation, comfort level, and satisfaction) to enhance thermal comfort prediction. Multiple Artificial Intelligence (AI) techniques-including Multiple Linear Regression (MLR), XGBoost, Random Forest, Multi-Layer Perceptron (MLP), and a Fuzzy Logic System (FLS)-were developed and systematically benchmarked against the PMV-PPD model. Results demonstrate that incorporating subjective data significantly improves prediction accuracy, reducing MLR's RMSE from 0.989 (objective-only) to 0.688 (combined data). The FLS achieved competitive performance (RMSE = 0.704) while offering high interpretability through transparent rule-based modeling. In addition to RMSE, Mean Absolute Error (MAE) and Mean Bias Error (MBE) were used to evaluate consistency and bias, confirming that MLR and FLS delivered low-error, low-bias predictions suitable for practical use. The novelty of this work lies in (i) the integration of objective and subjective data streams within a unified framework, (ii) the statistical validation of AI models' superiority over traditional PMV-PPD methods, and (iii) the introduction of an interpretable fuzzy logic model suitable for occupant-centered HVAC applications. These findings support the development of adaptive, explainable, and human-centric building systems for real-world deployment.

F. K. O'Connor, K. T. Janetos, B. J. Richards, R. C. Harris-Mostert, K. E. Wagar, L. G. Ioannou, J. J. McCormick, R. D. Meade, E. J. Tetzlaff, R. J. Sigal, W. S. Journeay and G. P. Kenny.

Defining Sex- and Age-Specific Initial Stay Times for Continuous Moderate-Intensity Work in Hot Environments Before Heat-Mitigation Controls Are Implemented - Part A.

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE. 2025.

https://doi.org/10.1002/ajim.70013

*Rationale Industry guidelines recommend work-rest allocations to limit increases in core temperature (Tcore; > 38.0 degrees C or > Delta 1.0 degrees C above resting) during work in the heat. However, the initial duration of permissible work before implementing these allocations is not specified (initial stay time [IST]) and individual factors such as sex and age affecting thermoregulation are not considered.
 Objectives The objective of this study was to assess whether factors of sex and age influence IST.
 Methods We examined the permissible work duration before reaching Tcore of 38.0 degrees C or Delta 1.0 degrees C above resting in young (18-30 years) and older (50-69 years) males and females performing moderate-intensity (200 W/m2) simulated work at ambient conditions of 26, 29, and 32*

*degrees C wet-bulb globe temperature (WBGT).
 Findings IST significantly decreased as ambient conditions intensified (p < 0.0001). Median (95% CI) durations to 38 degrees C across groups were 59 (43-87) minutes at 26 degrees C, 40 (34-65) minutes at 29 degrees C, and 35 (31-46) minutes at 32 degrees C WBGT. Likewise, median times to achieve Delta 1.0 degrees C above resting temperature significantly differed by environmental conditions (p < 0.0001): 66 (56-128) minutes at 26 degrees C, 68 (54-80) minutes at 29 degrees C, and 44 (41-53) minutes at 32 degrees C WBGT. Older females were significantly more likely to experience Tcore elevations of 38.0 degrees C (hazard ratio [95% CI]: (3.1 [1.6, 5.8], p < 0.001) and Delta 1.0 degrees C above resting (1.9 [1.1, 3.0], p = 0.007) compared to young males. In contrast, IST for young females and older males were similar to young males.
 Impact Our findings underscore the impact of hotter ambient conditions on IST and identify older females as particularly susceptible during moderate-intensity work in heat emphasizing the need for tailored occupational heat exposure guidelines.*

M. A. K. Houessou, Z. Elnour, Q. Q. Kong, H. Grethe and M. Huber.

Heat stress causes economic and welfare disparities across agroecological zones in Burkina Faso.

COMMUNICATIONS EARTH & ENVIRONMENT. 2025;6(1).

https://doi.org/10.1038/s43247-025-02650-1

Increased warming due to climate change can induce heat stress in humans and adversely affect labour productivity due to heat-related morbidity. Here, we use a simulation model to examine the effects of heat stress, through declined labour capacity under +1.5 degrees C and 3.5 degrees C warming scenarios on agriculture and welfare across the three agroecological zones (Sudanian, Sudano-Sahelian, and Sahelian) in Burkina Faso. In the two scenarios, domestic production declines, with outdoor labour-intensive sectors such as cropping and mining being the most affected, reducing gross domestic product by 9% and 20%, respectively. All households lose welfare in all scenarios except non-poor households in the +1.5 degrees C scenario. Across zones, crop production declines strongest in the crop-producing Sudanian and Sudano-Sahelian zones. In contrast, relative welfare losses are strongest for households in the Sahelian zone. The study highlights the most vulnerable sectors, household groups, and zones requiring urgent attention in heat stress adaptation and mitigation policies.

Y. L. Sun, B. C. Zhang, J. H. Qin, X. S. Jiang, R. S. Zang, J. Yu, Z. Liu and X. H. Zhang.

Highly sensitive and linear-response temperature sensor based on carbon nanotube/PDMS composites for body temperature monitoring.

JOURNAL OF MATERIALS SCIENCE-MATERIALS IN ELECTRONICS. 2025;36(25).

https://doi.org/10.1007/s10854-025-15668-0

Composite-based temperature sensors hold significant promise for body temperature monitoring, crucial for assessing health conditions and predicting diseases. However, achieving both high sensitivity and linear response in these sensors remains challenging. This study introduces a novel approach to high-performance temperature sensors by utilizing carbon nanotube (CNT)/polydimethylsiloxane (PDMS) composites. The temperature response characteristic of the sensors is influenced by the original morphology and contact status of CNT fillers. These factors can be adjusted through carefully controlling the processing parameters. By optimizing the curing temperature and CNT weight ratio, we developed sensors with high sensitivity and linear response within the temperature range of 30-70 degrees C. The optimal sensor based on composites composed of 1.5 wt% CNTs and cured at 75 degrees C achieves a sensitivity of 1.88% degrees C-1, a resolution of 0.1 degrees C, and a response time under

3 s. The sensors demonstrate potential for real-time body temperature monitoring and spatial temperature mapping. This work offers a simple but effective method to enhance the performance of composite-based temperature sensors.

P. O. Bodurtha, M. A. Shaw, A. M. Greenfield, D. M. Pitsas, B. K. Alba, J. W. Castellani, C. O'Brien and A. D. Seeley.

Immediate Load Carriage Improves Core Temperature but Not Skin Temperatures When Wearing Wet Clothing in Mild Cold Air.

WILDERNESS & ENVIRONMENTAL MEDICINE. 2025.

https://doi.org/10.1177/10806032251376323

Introduction - Members of the military are regularly exposed to austere environmental conditions that may create clothing saturation in cold conditions. This study sought to determine whether immediate ruck initiation is superior in maintaining rectal temperature (Tre), improving skin temperatures, and augmenting thermal comfort compared with remaining static and/or delayed ruck initiation when wet in cold air. Methods - Eleven healthy adults (10 males and 1 female, 26 +/- 9 y old, 22.5 +/- 8.6% body fat) participated in this study. Volunteers were immersed in warm water (34.0 +/- 0.3 degrees C) before entering the cold chamber (5.3 +/- 0.4 degrees C) and began immediately rucking (IR) or stood statically for 60 min (Static) before rucking (delayed rucking [DR]) for 60 min. Results - IR initiation was superior in elevating Tre compared with Static at 20 min (37.6 +/- 0.4 vs 37.3 +/- 0.2 degrees C, P=0.033), 40 min (37.9 +/- 0.4 vs 37.5 +/- 0.2 degrees C, P=0.012), and 60 min (37.9 +/- 0.4 vs 37.6 +/- 0.3 degrees C, P=0.016). IR Tre was also greater than DR at 40 min (37.9 +/- 0.4 vs 37.4 +/- 0.5 degrees C, P=0.002) and 60 min of wet-cold exposure (37.9 +/- 0.4 vs 37.5 +/- 0.5 degrees C, P<0.001). Consequently, IR tended to improve thermal sensation ratings compared with both DR and Static. Yet, IR was no more sufficient in overcoming wet-cold decrements in skin temperatures than Static, especially at the finger (P>0.05). Conclusions - Compared with DR and Static, IR is effective at elevating deep body temperature and improving thermal perceptions but is significantly less effective at improving wet-cold skin temperatures compared with Static.

Y. H. Yan, J. Geng, X. Cui, Z. H. Ju and G. Y. Wang.

iThermonitor: A wearable non-invasive high-precision alternative to traditional temperature monitoring in thoracoscopic surgery of lateral decubitus position.

JOURNAL OF CLINICAL MONITORING AND COMPUTING. 2025.

https://doi.org/10.1007/s10877-025-01348-1

In thoracoscopic surgery, temperature monitoring is essential but traditionally relies on invasive methods such as esophageal or rectal thermometry, which risk mucosal injury and patient discomfort. This trial evaluates the iThermonitor, a wireless wearable axillary thermometer, as a non-invasive alternative aiming to minimize procedural trauma while maintaining clinical accuracy. We enrolled 80 adult patients scheduled for thoracoscopic surgery under general anesthesia between December 1, 2023, to May 31, 2024. Axillary temperature (iThermonitor) and lower esophageal temperature (reference standard) were recorded every 3 minutes. The primary endpoint was the agreement between devices (+/- 0.5 degrees C). Among 3536 temperature pairs, 93.96% of iThermonitor readings were within +/- 0.5 degrees C of lower esophageal values (95% CI: 91.94-95.85%), with strong correlation (Pearson r = 0.75, P < 0.0001). The device demonstrated high diagnostic accuracy for hypothermia (<36.0 degrees C; AUC = 0.876). Esophageal probes caused bloodstaining in 73.8% of

cases, whereas iThermonitor-related skin redness (45%) resolved postoperatively. The iThermonitor is a reliable and accurate non-invasive alternative to traditional invasive temperature monitoring methods in thoracoscopic surgery. It effectively detects perioperative hypothermia and offers significant patient-centered benefits, including enhanced comfort and safety.

Z. Y. Xiang, C. B. Zeng, Y. Z. Wu, Y. P. Yu, M. Tang, K. Wei, J. Shang, H. Y. Wang, Y. W. Liu and R. W. Li.

A low-interference and highly comfortable wearable sensor for dynamic sweat monitoring.

MICROCHEMICAL JOURNAL. 2025;218.

https://doi.org/10.1016/j.microc.2025.115456

Sweat, as a biofluid rich in physiological information, has secretion volume and rate that serve as critical indicators for assessing body hydration status, thermal stress response, and metabolic function. However, traditional detection methods relying on laboratory analysis struggle to achieve real-time monitoring, while existing wearable sensors still face limitations in wearing comfort, and environmental adaptability. This study presents a wearable sweat rate sensor based on planar interdigitated capacitance principles, addressing the shortcomings of conventional technologies through innovative structural design. The sensor employs an electrospinning technique to fabricate a silk fibroin/PVDF hydrophilic-hydrophobic directional transport membrane, combining biocompatibility with breathability to significantly enhance wearing comfort. By integrating a hydrophilic microfluidic channel with a layered planar interdigitated electrode structure, it enables real-time, continuous capacitive signal detection (sensitivity: 0.105 s(-1), linearity: R-2 = 0.99) through dielectric constant changes induced by sweat flow. Notably, its performance remains unaffected by sweat ion concentration (0-100 mmol/L) or environmental temperature and humidity (25-45 degrees C, 60-90 % RH). Experimental validation confirms the sensor's ability to accurately monitor dynamic sweat secretion during physical activity. Its fabrication process, combining electrospinning and screen printing technology, facilitates scalable production. This research provides a high-precision, high-comfort, and environmentally robust solution for wearable sweat monitoring, demonstrating significant application potential in health tracking and exercise physiology.

H. T. Wu, H. H. Zhao, Z. C. Nie, L. Y. Yao and L. H. Zhao.

Pedestrians thermal responses under variable exposure conditions during heatwaves.

SUSTAINABLE CITIES AND SOCIETY. 2025;131.

https://doi.org/10.1016/j.scs.2025.106703

Given the exacerbated urban overheating caused by the combined effects of urban heat islands and heatwave events, there is an urgent need to develop practical strategies to enhance urban heat resilience. Before implementing sustainable urban strategies to better serve the public, research must prioritize thermophysiological mechanisms, including how variable outdoor thermal exposure affects human physiology, the characteristics of changes in key physiological parameters, and accurate assessment of outdoor thermal environments based on thermophysiology. To address these issues, this study conducted foundational experiments to investigate these questions. We recruited 15 volunteers to simulate thermal exposure during commuting under heatwave conditions, analyzing the comprehensive impact of variable outdoor thermal exposure on human thermophysiology (skin temperature and core temperature) through regression analysis. Subsequently, we assessed the applicability of the widely used "skin temperature-thermal sensation" model and equivalent physiological models under hightemperature conditions and identified key challenges for developing

future thermal evaluation metrics in such environments. This study provides novel insights and solutions for pedestrian thermal management during heatwaves, contributing to reducing human thermal vulnerability and supporting sustainable urban design.

Travail par fortes chaleurs et périodes de canicule

S. Y. Hong, J. Q. Wang, G. Chen and S. J. Cao.

Heat exposure patterns and human adaptations under heatwaves: a systematic analysis across sociodemographic groups.

ENVIRONMENT DEVELOPMENT AND SUSTAINABILITY. 2025.

https://doi.org/10.1007/s10668-025-06759-3

Heatwaves present an escalating threat to public health, with impacts influenced not only by heatwave intensity but also by sociodemographic disparities in exposure and adaptive capacity. Most existing studies analyze heat exposure and adaptive behaviors separately, obscuring the accurate identification of vulnerable groups characterized by both high exposure and limited adaptation. Furthermore, the role of media-based heatwave warnings in shaping adaptive behaviors across different populations remains insufficiently examined, constraining the design of targeted interventions. This study draws on survey data collected through snowball sampling from 562 Chinese respondents between October and November 2023 to examine sociodemographic differences in outdoor heat exposure and three prevalent adaptive behaviors: visiting cooling centers, deploying sunshades, and using air conditioning. It further examines how these behaviors are associated with risk perception (measured by perceived heatwave severity) and media exposure across sociodemographic groups. Logistic regression reveals the uneven exposure risk: middle-aged, moderate-income commuters and non-local outdoor workers exhibit the higher exposure risk. Regarding adaptive behaviors, education level strongly predicts the cooling center use. Sunshade utilization correlates with gender and local residency, while air conditioning use varies by income and perceived heat severity. These findings emphasize the need for tailored interventions: media-optimized warnings for elderly populations, heatwave subsidies for outdoor and low-income workers, and expansion of cooling infrastructure in urban heat hotspots. By delineating vulnerable groups and their distinct adaptive patterns, the study supports more equitable and effective governance of heatwave risks.

H. A. Yoder, A. M. Mulholland, E. C. Johnson, L. J. Winchester and J. E. Wingo.

Physiological responses to heat stress in groundskeepers: an observational field study.

APPLIED PHYSIOLOGY NUTRITION AND METABOLISM. 2025;50.

https://doi.org/10.1139/apnm-2025-0106

The extent to which groundskeepers experience thermal and cardiovascular strain, dehydration, and accompanying declines in kidney function during work in hot-humid conditions is unknown. Demographics, thermal and cardiovascular strain, hydration, and kidney function were assessed in 20 groundskeepers (18 men; mean +/- SD, age = 37.9 +/- 8.4 years, body mass index = 31.5 +/- 7.5 kg<middle dot>m-2) during work on two summer days. Before (AM) and after (PM) the work shift, resting blood pressure (BP) and heart rate (HR) were measured and urine and blood samples were collected. During the work shift, fluid intake was recorded, gastrointestinal temperature (TGI) was recorded, and HR was recorded continuously. In 45% of participants, AM BP > 130/80 mm Hg on Day 1 and Day 2. Peak HR and TGI achieved across both days were 143 +/- 15 b<middle dot>min-1 and 37.7 +/- 0.3 degrees C, respectively, and average peak wet bulb globe temperature was 39.1 +/- 3.5 degrees C. On both days, urine specific gravity (USG = 1.021 +/- 01) and urine color (UCOL = 6 +/- 1) did not change across the work shift (all P > 0.28), but most subjects began with concentrated urine (62.5% USG >= 1.020 and 95% UCOL >= 4). Total fluid intake = 2.3 +/- 1.6 L during work and consisted of 70%

water, 25% sugar-sweetened beverages, 5% other. For six subjects, the average estimated glomerular filtration rate (eGFR) at AM was <= 60 mL<middle dot>min-1<middle dot>1.73 m-2. Five subjects had SCr increases from AM to PM >= 0.3 mg<middle dot>dL-1, signifying an acute kidney injury (AKI). While hyperthermia was not prevalent, subjects began and ended the workday with concentrated urine. Hypertension, obesity, and low water intake may have contributed to the overall low kidney function and AKIs observed.

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Precise Prediction and Tiered Mitigation Strategies for Thermal Hazards in Deep Mines: A Data-Driven Approach Applied to Shicaocun Coal Mine.

APPLIED GEOPHYSICS. 2025.

https://doi.org/10.1007/s11770-025-1266-0

As mineral resource exploitation progresses deeper, high-temperature thermal hazards present a critical challenge, severely impacting coal mine productivity and worker health. To develop a cost-effective and adaptable integrated control system for thermal hazards in deep mines, this study proposes an innovative strategy based on multi-source field data for precise thermal environment prediction and tiered mitigation. Utilizing extensive on-site temperature measurements and thermophysical properties of rock and coal, a numerical model to predict the deep mine thermal environment was developed. This model facilitated a detailed analysis of heat sources, thermal distribution characteristics, and mitigation technologies within the Shicaocun Coal Mine. It was indicated that heat release from surrounding rock strata and mine water influx are the predominant thermal hazards and heat transfer exhibits preferential pathways along geological faults. Increasing airflow velocity, lowering initial airflow temperature, and reducing heat source power are effective countermeasures, achieving temperature reductions of 38%, 39.2%, and 33.3%, respectively. The thermal impact range at the working face varies seasonally: 118 m (Spring, with inlet air temperature 20 degrees C), 215 m (Summer, with inlet air temperature 32 degrees C), 118 m (Autumn, with inlet air temperature 20 degrees C), and 80 m (Winter, with inlet air temperature 5 degrees C). Consequently, seasonally adaptive mitigation strategies are proposed: localized cooling stations or surface-based refrigeration are recommended for Spring, Summer, and Autumn. Critical mitigation pathways identified include disrupting heat release from coal gangue, minimizing moisture evaporation from walls, dispersing heat from electromechanical equipment, and optimizing ventilation systems to lower air temperature and reduce heat load. This study provides a robust theoretical foundation for thermal environment management at Shicaocun Coal Mine and offers valuable insights for similar deep mining operations globally.

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Protecting Workers from Extreme Heat; US Department of Labor has Proposed a Much-Needed Regulation; Can it Survive Trump? Commentary on the Essay "An Elusive Promise: Protecting US Workers from Excessive Heat".

NEW SOLUTIONS-A JOURNAL OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH POLICY. 2025.

https://doi.org/10.1177/10482911251374212

In the essay "An Elusive Promise: Protecting US Workers from Excessive Heat," the author (who is also the author of this commentary) addresses the ever-increasing hazard that exposure to excessive heat poses to workers, both internationally and in the United States, and details the history of federal efforts

to address the problem, dating back to the passage of the Occupational Safety and Health Act (the "OSH Act") in 1970. Following years of dogged advocacy by the worker safety community, those efforts culminated in August 2024 in the publication in the Federal Register of a Notice of Proposed Rulemaking for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings. A few months later, Donald Trump was elected president. This commentary examines whether the proposed rule can survive his presidency.

Actualités septembre 2025

- ## Travail par fortes chaleurs et périodes de canicule

La protection des salariés face aux risques liés à la chaleur. Associationsmodeemploi.fr, 02 septembre 2025

La RATP à l'épreuve du climat : du « risque infrastructure » au confort des usagers... et des salariés. Lejournaldumgrandparis.fr, 07 septembre 2025

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MoHAP, partners conclude 14th Heat Exhaustion and Disease Prevention Campaign in Sharjah. Mohap.gov.ae, 09 septembre 2025

Extreme Heat Spurs New Laws Aimed at Protecting Workers Worldwide. Nytimes.com, 13 septembre 2025

- ## Maladies liées à la chaleur

Heatstroke Versus Heat Exhaustion: What's the Difference? Everydayhealth.com, 10 septembre 2025

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- ## EPI, matériaux protecteurs/refroidissants

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Safety community says it is poised to move forward to protect workers from extreme heat. Businessinsurance.com, 24 septembre 2025