# Bulletin n°25

# Veille thermique
# Période : décembre 2024

## 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 :

# *INRS-Biblio*

- **Documents INRS**

J. Clerte and M. Malenfer.

**Enjeux du réchauffement climatique en santé au travail.**

IC RST - Infos à retenir, Références en santé au travail. 2024(179):5-7, 3.

https://www.inrs.fr/media.html?refINRS=AC%20188

*Le 34e congrès de la Commission internationale de la santé au travail/International commission on occupational health (CIST/ICOH) s'est déroulé à Marrakech du 28 avril au 3 mai 2024. Il s'agit du principal événement international rassemblant les acteurs de la santé au travail dans l'objectif d'encourager le progrès scientifique, la connaissance et le développement de cette discipline et des sujets qui s'y rapportent.*

# EPI, matériaux protecteurs/refroidissants

G. Li, D. Watanabe and M. Miyachi.

**Acute Effects of Wearing a Cooling Vest after High-Intensity Running and at Rest on Energy Intake and Appetite in Young Men.**

MEDICINE & SCIENCE IN SPORTS & EXERCISE. 2024;56(12):2275-84.

https://doi.org/10.1249/MSS.0000000000003512

*Purpose: Body cooling during and after exercise stimulates energy intake (EI). Cooling vests can also reasonably decrease body temperature under various sport occasions. This study examined the acute effects of wearing a cooling vest on EI and appetite after exercise and rest. Methods: Fifteen healthy young men underwent four trials randomly in a thermoneutral room (similar to 24 degrees C, similar to 40% humidity). In two exercise trials, participants performed a 60-min run at 75% of maximum oxygen uptake and wore a cooling vest (ExC) or thermoneutral vest (ExN) from 1030 to 1130 h. In two resting trials, participants rested for 60 min and wore a cooling vest (RC) or a thermoneutral vest (RN) from 1030 to 1130 h. From 1130 h, participants consumed a buffet meal until satiety. EI was calculated from the buffet meal. Skin and rectal temperatures were assessed between 0930 and 1130 h. Results: EI was significantly higher in the ExC trial (1740 +/- 642 kcal) than in the ExN trial (1584 +/- 604 kcal) and higher in the RC trial (1879 +/- 806 kcal) than in the RN trial (1726 +/- 806 kcal). Hot food consumption was significantly higher in the ExC trial than in the ExN trial and higher in the RC trial than in the RN trial. Subjective hunger was significantly higher in the ExC trial than in the ExN trial. Lower rectal temperatures were associated with higher relative EI (beta = -8.871, P < 0.001). Conclusions: Wearing a cooling vest increased EI after exercise or rest and increased subjective appetite only after exercise. Increased EI may result from a preference for hot foods altered by a cooling vest.*

F. Acs, Z. Szalkai, E. Kristóf and A. Zsákai.

**A Comparison of the Effects of Climate and Human Variability on the Thermal Resistance of Clothing.**

ATMOSPHERE. 2024;15(12).

https://doi.org/10.3390/atmos15121474

*We used a clothing thermal resistance model to investigate and compare the effects of climate and human variability on human thermal load. To investigate the effect of climate variability, we introduced the mean clothing thermal resistance rcl<overline>. For characterizing the effect of human variability, we used the standard deviation of clothing thermal resistance triangle rcl. We distinguished people based on their body type. We also defined the average human, a man and a woman, with thermal resistances of rcl,m and rcl,f. The investigation was carried out for the European region in the cold season for the period of 1981-2010. The climate variables were taken from the ERA5 reanalysis database. Our most important results are the following. (1) The macroscale pattern of the rcl<overline> and triangle rcl fields are very similar, based on which it can be stated that human variability does not modify the spatial distribution of rcl<overline>. (2) The triangle rcl values are roughly a quarter of the rcl<overline> values. The highest rcl<overline> values (3.2-3.4 clo) are in Lapland, and the smallest (1-1.2 clo) in Andalusia. (3) The macroscale pattern of the rcl,m and rcl,f fields is similar to the macroscale pattern of the rcl values of the mesomorphic person rcl,2. The field of rcl,2 can be used for climate classification purposes.*

K. Rui, J. Z. He, M. Y. Xin, Z. W. Chen and J. P. Guan.

**Effects of air gap and compression on the dual performance of multilayer thermal protective clothing under low radiant heat.**

JOURNAL OF INDUSTRIAL TEXTILES. 2024;54.

https://doi.org/10.1177/15280837231221293

*An air gap in thermal protective clothing (TPC) plays an important role in determining heat transfer, but it may also increase the amount of stored thermal energy that would discharge to the skin after exposure, especially when the TPC suffers compression. To investigate the effect of air gap and compression on the dual thermal protective performance (TPP), thermal hazardous performance (THP) and overall thermal protective performance (OTPP) of TPC, nine air gap configurations with different sizes and positions and five compression levels were designed in this study. Regression models were established to explore the relationships among air gap size, compression and THP for different air gap positions. The results demonstrate that increasing the air gap size without exceeding 12 mm not only significantly enhances the TPP by impeding heat transfer from the heat source to the fabric system during exposure but also decreases the THP by reducing heat discharge from the fabric system to the sensor even when compression is applied. Although an inner air gap contributes more to increasing the TPP during exposure than an outer air gap, it may also bring about severe stored energy discharge when compression is applied. It suggests that a larger air gap size should be divided into individually separate air gaps within different fabric layers to reduce the heat transfer during exposure as well as lower the stored thermal energy discharge after exposure.*

U. Ciuha, S. Podgornik, J. T. Fisher, B. Marolt and I. B. Mekjavic.

**Efficacy of a prototype ventilated vest in mitigating physiological and cognitive impairments during simulated military tasks in hot environments.**

JOURNAL OF THERMAL BIOLOGY. 2024;126.

https://doi.org/10.1016/j.jtherbio.2024.104014

*Many occupations, including military and industrial, cannot benefit from large-scale cooling strategies; therefore, personal cooling strategies may be more appropriate. We assessed the efficacy of a ventilated vest (Vest) based on participant' autonomic and cognitive responses during military-related activities in the heat. Male soldiers conducted 90-min trials in 35 degrees C ambient temperature and 40% relative humidity: i) March with/without Vest (N = 10), ii) Guard duty with/without Vest (N = 8). During each trial, we monitored their physiological (gastrointestinal temperature, T-gi; skin temperature, T-skin; torso microclimate temperature/humidity, M-T/M-RH; oxygen uptake, VO2; Heart rate, HR) and cognitive (reaction time, number of errors) and subjective responses. While some elements of T-gi, T-skin, M-T, and HR reduction in the Vest trial were observed, these decrements were small and persisted only for a short period of time. VO2 was significantly affected by the exercise but unaffected by the Vest (with vs. without) ($p > 0.05$). Cognitive performance did not improve significantly with the use of the Vest. However, reaction time improved after both trials. Sweat accumulation in the near-to-skin clothing layer was 2x (March) and 9x (Guard) higher ($p < 0.001$) without the vest, and participants reported feeling more comfortable and cooler when wearing the vest. The significantly lower sweat accumulation in the next-to-skin clothing layers when wearing the Vest improved thermal comfort and sensation, which was not reflected in the autonomic and cognitive response under the prevailing conditions. Possibly, a more powerful and upgraded concept of the vest could result in improved physiological and cognitive performance.*

S. Liu and J. Wu.

**Investigation of user needs of Chinese mature adults for intelligent-heated clothing based on Kano model.**

INTERNATIONAL JOURNAL OF FASHION DESIGN TECHNOLOGY AND EDUCATION. 2024.

https://doi.org/10.1080/17543266.2024.2432920

*This study explores the user needs of Chinese mature adults for intelligent heated clothing by using the Kano model to develop a comprehensive framework for investigation purposes. An analysis of the attributes which are categorised as 'Must-Be', 'One-Dimensional', 'Attractive', and 'Indifferent' is carried out, which provides critical insights into the priorities of ageing consumers. The user needs for intelligent-heated clothing are categorised into five types: psychological, psychological, functional, aesthetics and consumer needs, which are then placed into a four-quadrant diagram for better and worse scoring. Moreover, the impacts of satisfaction and dissatisfaction towards the different items are estimated and ranked. As such, the needs of the respondents can be determined systematically. This research work serves as a source of reference for furthering the development of intelligent-heated garments, and contributes to enhancing user satisfaction and the success of smart clothing tailored for the mature adult population.*

Y. J. Liu and X. Y. Jiao.

**Multi-functional flexible PANI-based material for the development of efficient heating sensing equipment: integrating intelligent heating, motion detection, moisture absorption and ultraviolet protection function.**

MATERIALS TODAY CHEMISTRY. 2024;42.

https://doi.org/10.1016/j.mtchem.2024.102411

*With the advancement of technology and the improvement of living standards, multifunctional composite materials are increasingly attracting attention. Conductive polymer polyaniline (PANI), a key component in the fabrication of intelligent composite materials, is widely used in various fields because of its unique properties. When FeCl3 was used as the oxidant, the PANI-based composite material demonstrated a significant increase in maximum saturation temperature from 34.10 degrees C to 47.43 degrees C, under a voltage range of 6-12 V. It also exhibited a sensitivity of 1.0960 kPa- 1 (greater than 1 kPa-1) at a low pressure of 0.5 kPa, and its response/recovery time is 200 ms for both. Its maximum capillary rise height reached 7.7 cm. Additionally, the PANI-based composite material achieved a UPF value 40+, effectively blocking over 97.5 % of ultraviolet rays. It also absorbed over 90 % of electromagnetic waves within the 0-18 GHz frequency range. The wear resistance has also been significantly improved compared to pure cotton fabrics, with the friction times reaching 1370 before damage when FeCl3 is used as the oxidant for this composite material. The PANI-based composite material developed in this study functions of intelligent heating, motion detection, moisture absorption, and UV protection functions. It holds the potential to develop efficient heating and sensing devices, offering a solution for the design of the next generation of multifunctional flexible composite materials.*

H. Q. Zhou, Y. L. He, T. Liu, Y. Liu, J. A. Shang and X. M. Wang.

**NEST: Network-Energy-Stress Threat Against Thermal Energy Equipment.**

IEEE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINEERING. 2024.

https://doi.org/10.1109/TASE.2024.3510336

*Thermal energy equipment, a critical component for transferring and utilizing thermal energy derived from primary energy sources, is indispensable in Industrial Control Systems (ICSs). With the deep integration of information technologies, ICSs are threatened by new cyber-physical security risks, where the physical systems could be influenced by attacks from the cyber network. While cyber-physical security risks in ICSs have been well studied in various domains, such as power systems and smart structural systems, little attention has been paid to the cyber-physical security of thermal energy equipment. In this paper, we propose a novel cyber-physical threat against thermal energy equipment, namely the Network-Energy-Stress Threat (NEST), which reveals attacks from the cyber network could induce an inhomogeneous distribution of thermal energy, thus causing remarkable thermal stress that can induce physical damage to the thermal energy equipment. From the attacker's perspective, we propose an inherent vulnerability-based algorithm to explore the threat space of potential attack strategies and find an approximately optimal attack strategy utilizing the nonlinear NEST model. Then, we propose a cyber-physical defense method to detect anomalous states stemming from the NEST. Experimental results on a simulated Solar Power Tower (SPT) plant have validated the existence of the NEST against thermal energy equipment and demonstrated the effectiveness of the proposed algorithm and the proposed detector.*

# *Maladies liées à la chaleur*

R. C. Chicas, C. Zhuang, A. Castellano, L. Trejo, E. Ruiz and V. Hertzberg.

**Acute Kidney Injury Among Florida Construction Workers: A Pilot Study.**

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE. 2024.

https://doi.org/10.1002/ajim.23692

*Background: While construction workers have the second highest rate of heat-related mortality, less is known about the prevelance of heat-related illness (HRI) symptoms, dehydration and kidney dysfunction. The aim of this study was to conduct a biomedical field-based study with construction workers to characterize HRI symptoms, dehydration, and kidney dysfunction, and analyze relationships between post-work urine specific gravity (USG) percentiles and predictors such as work hours, water consumption, and sugary beverage consumption.MethodsIn collaboration with the Farmworker Association of Florida, 58 construction workers in Central Florida were monitored pre- and post-work shift on one workday. Research staff used a recreational vehicle to meet workers at their worksites, collect blood and urine pre- and post-work shift, and administer a survey on HRI symptoms. Acute kidney injury (AKI) was measured using serum creatinine and dehydration with USG. Predictors were examined in single covariate linear quantile mixed models against USG percentiles.ResultsThe mean heat index was 88.4 degrees F. Forty-two percent reported at least one symptom of HRI. Dehydration rates were 75% pre-work shift and 78% post-work shift. Severe dehydration increased from 16% to 33%. AKI was observed in 38% of the participants.ConclusionThis is, to our knowledge, the first US field-based biomedical study to document AKI, dehydration, and HRI symptoms in construction workers. This study adds to the literature that supports occupational heat exposure as a risk factor for AKI and dehydration.*

B. Angol, S. Sousan and J. A. G. Balanay.

**Comparison between WBGT app prototype and WBGT monitor to assess heat stress risk in an eastern North Carolina outdoor setting.**

JOURNAL OF OCCUPATIONAL AND ENVIRONMENTAL HYGIENE. 2024.

https://doi.org/10.1080/15459624.2024.2444415

*The wet bulb globe temperature (WBGT) index is the preferred environmental heat metric for occupational heat-related illness prevention but may not always be readily accessible in the workplace. Thus, there is a need for well-designed WBGT-based tools that are reliable, accessible, and inexpensive. A novel WBGT app prototype was developed to calculate the current and forecasted outdoor WBGT. The purpose of this study was to assess the reliability of the WBGT app prototype in providing accurate heat stress risk information for outdoor workplace settings in eastern North Carolina by comparing the WBGT indices and risk levels from the app (WBGT(app)) with those derived from a heat stress monitor (WBGT(ins)). Outdoor WBGT measurements were data logged at a university campus site using a heat stress monitor from March to August 2023 for 81 days and were assigned to risk levels by workload based on the ACGIH Threshold Limit Values. Hourly WBGT(app) values and their corresponding risk levels were obtained using the app prototype. Data analysis was conducted using a t-test, Pearson correlation test, and cross-tabulation. Results showed that the hourly mean WBGT(app) was significantly higher ($p < 0.01$) than the WBGT(ins), but there was no significant difference between the overall average of the daily mean ($p = 0.15$) and daily maximum ($p = 0.69$) WBGT(app) and WBGT(ins). There was a strong, positive correlation between the hourly mean ($r = 0.94$, $p < 0.01$), daily mean ($r =$*

*0.97, p < 0.01), and daily maximum (r = 0.94, p < 0.01) WBGT(app) and WBGT(ins). The app correctly identified 73-88% of minimal-risk conditions, depending on workload type, and was most reliable in correctly identifying extreme-risk conditions at 97%, 95%, and 93% for light, moderate, and heavy workloads, respectively. This demonstrates the app's capability of being protective of the workers, particularly in more severe heat stress risk conditions. Recommendations to improve the app's accuracy involved using accurate solar irradiance data and applying linear calibration. The WBGT app prototype shows good potential as an alternative risk assessment tool for heat stress risk among outdoor workers.*

M. Murray, S. Beckman, A. Heinzerling, M. Frederick, K. J. Cummings, S. Gandhi and R. Harrison.

**Heat-Related Illness in California Firefighters, 2001-2020.**

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE. 2024.

https://doi.org/10.1002/ajim.23691

*Background: Firefighters have a higher rate of heat-related illness (HRI) compared to other occupations. Given the changing climate, firefighters' risk of occupational HRI merits attention. Therefore, we aimed to identify demographic, temporal, and geographic risk factors associated with occupational HRI in California firefighters between 2001 and 2020.MethodsWithin the California Workers' Compensation Information Systems (WCIS), we identified firefighters from 2001 to 2020 using industry and class codes and assigned occupation titles using the NIOSH Industry and Occupation Computerized Coding system (NIOCCS). HRI claims among firefighters were identified using International Classification of Diseases (ICD) Ninth or Tenth revision codes, WCIS nature and cause of injury codes, and keywords. We calculated HRI incidence rates adjusted by sex, age, year, and county. Estimates of California firefighter employment were obtained from the American Community Survey.ResultsWe identified 2185 firefighter HRI claims between 2001 and 2020 (305.5 claims/100,000 firefighters, 90% CI: 278.7-740.7). Firefighters aged 18 to 29 years had a statistically significant higher risk of HRI compared to those aged 40 to 49 years (rate ratio = 3.5, 90% CI: 3.1-3.9). The HRI rate increased over time, and the risk from 2016 to 2020 was 1.8 times higher than it was from 2001 to 2005 (90% CI: 1.7-1.9). Northern California counties, including Shasta (2313.9) and Sacramento (1772.1), had the highest HRI rates.ConclusionsFirefighters in certain demographic groups and northern California counties were at highest risk of HRI. With rising temperatures and larger wildfires, additional prevention efforts are needed to reduce HRI in California firefighters.*

S. P. Parajuli, T. Biggs, F. de Sales, M. A. Zavala Perez, C. He, C. Jones, C. Thompson, N. L. Galvez, H. Ciborowski, T. Quintino, C. Di Napoli, A. Montazar, T. H. Yazdi and M. Soucier.

**Impact of irrigation on farmworkers' heat stress in California differs by season and during the day and night.**

Communications Earth & Environment. 2024;5(1).

https://doi.org/10.1038/s43247-024-01959-7

*Farmworkers, the frontline workers of our food system, are often exposed to heat stress that is likely to increase in frequency and severity due to climate change. Irrigation can either alleviate or exacerbate heat stress, quantification of which is crucial in intensely irrigated agricultural lands such as the Imperial Valley in southern California. We investigate the impact of irrigation on wet bulb globe temperature (WBGT), a key indicator of heat exposure in humans, using a validated high-resolution Weather Research and Forecasting (WRF) regional climate model, during day and night and in different seasons. We find that irrigation reduces WBGT by 0.3–1.3 °C during the daytime in summer due to*

*strong evaporative cooling. However, during the summer nights, irrigation increases WBGT by 0.4–1.3 °C, when a large increase in humidity sufficiently raises the wet-bulb temperature. Urban and fallow areas adjacent to cropped fields also experience increased heat stress due to moisture advection from irrigated areas. Our results can inform heat-related policies in agricultural regions of California and elsewhere.*

A. Edgerly, G. L. Gillespie, A. Bhattacharya and B. M. Hittle.

**Ohio Farmworkers and Heat-Related Illness Prevention.**

JOURNAL OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE. 2024;66(12):1015-21.

https://doi.org/10.1097/JOM.0000000000003230

*The aim of the study is to understand farmworkers' knowledge of heat-related illness prevention and behavioral and cultural factors related to heat-related illness (HRI) prevention. The theory of planned behavior and an ethnographic study design were used. Data collection consisted of observations and interviews. Recorded interviews were conducted with participants and transcribed verbatim. Transcribed interviews were analyzed using thematic analysis. Overall, 14 interviews were conducted, and four themes emerged: acquisition and interpretation, perception, interoception, and action. Other findings included an insufficiency of formal training and the absence of knowledge of a protocol for acclimatization.Better education and training are needed in this occupation, especially regarding acclimatization. Occupational health professionals must lead efforts to develop HRI plans and measures to ensure acclimatization protocols are adopted in the workforce.*

# *Outils et capteurs de mesure*

J. R. Lanzante.

**A New Heat Stress Index for Climate Change Assessment.**

BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY. 2024;105(12).

https://doi.org/10.1175/BAMS-D-24-0030.1

*The heat index (HI), based on Steadman's model of thermoregulation, estimates heat stress on the human body from ambient temperature and humidity. It has been used widely both in applications, such as the issuance of heat advisories by the National Weather Service (NWS) and for research on possible changes in the future due to climate change. However, temperature/ humidity combinations that exceed the applicable range of the model are becoming more common due to climate warming. Recent work by Lu and Romps has produced an extended heat index (EHI), which is valid for values outside the range of the original HI. For these values, the HI can underestimate the EHI by a considerable amount. This work utilizes observed data from 15 U.S. weather stations along with bias-adjusted output from a climate model to explore the spatial and temporal aspects of the disparity between the HI and the EHI from the recent past out to the end of the twenty-first century. The underestimate of human heat stress by the HI is found to be the largest for the most extreme cases (5 degrees-10 degrees C), which are also the most impactful. Conditions warranting NWS excessive heat warnings are found to increase dramatically from less than 5% of days historically at most stations to more than 90% in the future at some stations. Although, by design, the scope of this work is limited, it demonstrates the need for the adoption of the EHI for both applications and research.*

Y. B. Du, C. L. Zhou, Y. H. Feng and L. Qiu.

**Flexible, multimodal device for measurement of body temperature, core temperature, thermal conductivity and water content.**

NPJ FLEXIBLE ELECTRONICS. 2024;8(1).

https://doi.org/10.1038/s41528-024-00373-5

*Body core temperature is an important physiological indicator for self-health management and medical diagnosis. However, existing devices always fails to achieve continuous monitoring of core body temperature due to their invasive or motion-restricted measurement principles. Here, a wearable flexible device which can continuously monitor the core body temperature was developed. The flexible device integrated with fourteen temperature sensors and one thermal conductivity sensor on the polydimethylsiloxane substrate can be conformally attached to the human skin. With the wearable data processing module and wireless communication module, the continuous monitoring of the core body temperature for 24 h and the portable monitoring of the skin thermal conductivity were realized using this device. Owing to the annular distribution design of the temperature sensor and the directional heat transfer design of the thermal conductivity sensor, this device is comparable in accuracy and stability compared to standard instruments that require invasive or motion-restricted measurements.*

# Travail dans une ambiance thermique extrême

S. Azam, S. M. Liu, S. Bhattacharyya and S. Y. Zheng.

**Assessing the hazard of diesel particulate matter (DPM) in the mining industry: A review of the current state of knowledge.**

INTERNATIONAL JOURNAL OF COAL SCIENCE & TECHNOLOGY. 2024;11(1).

https://doi.org/10.1007/s40789-024-00707-8

*In the confined spaces of underground mines, the exposure of over 10,000 miners in the U.S. to diesel exhaust and diesel particulate matter (DPM) is an occupational inevitability, particularly in metal and nonmetal mineral extraction. These workers routinely operate amidst diesel-powered equipment, often outdated and highly polluting, extracting resources such as limestone, gold, and salt. The acute health effects of such exposure are significant, leading to symptoms like headaches and flu-like conditions, with the impact being more pronounced in these closed work environments. This review scrutinizes DPM's hazard in the mining sector, consolidating the extant knowledge and exploring ongoing research. It encapsulates our understanding of DPM's physicochemical properties, existing sampling methods, health ramifications, and mitigation technologies. Moreover, it underscores the necessity for further study in areas such as the evolution of DPM's physicochemical attributes, from its genesis at high-pressure, high-temperature conditions within diesel engines to its emission into the mine atmosphere. A key research gap is the intricate interaction of DPM with specific characteristics of the mine environment-such as relative humidity, ambient temperature, the presence of other mineral dust, and the dynamics of ventilation air. These factors can significantly alter the physicochemical profile of DPM, influencing both its in-mine transport and its deposition behavior. Consequently, this can affect the respiratory health of miners, modifying the toxicity and the respiratory deposition of DPM particles. Identified research imperatives include (1) the advancement of instrumentation for accurate number measurement of DPM to replace or supplement traditional gravimetric methods; (2) the development of long-lasting, cost-effective control technologies tailored for the mining industry; (3) an in-depth investigation of DPM interactions within the unique mine microclimate, considering the critical components like humidity and other aerosols; and (4) understanding the differential impact of DPM in mining compared to other industries, informing the creation of mining-specific health and safety protocols. This review's findings underscore the urgency to enhance emission control and exposure prevention strategies, paving the way for a healthier underground mining work environment.*

C. G. Vázquez, M. Fujs, M. F. Koller, P. Wolf and G. Da Poian.

**Beat the heat: wearable-based study of perceived heat stress and physiological strain in swiss track workers in a controlled climate chamber.**

PHYSIOLOGICAL MEASUREMENT. 2024;45(12).

https://doi.org/10.1088/1361-6579/ad9683

*Increasing temperatures pose new challenges for track workers (TWs), who endure prolonged exposure to extreme heat and humidity. New methods are critically needed to assess their performance and heat tolerance, aiming to mitigate workplace accidents and long-term health consequences. This study aimed to investigate the physiological effects of heat exposure on TWs, using wearable sensors to monitor key physiological parameters under controlled environmental conditions. Nineteen TWs participated in the study, which included two experimental sessions simulating different thermal environments: a typical Swiss summer night and a hot summer day. Participants' core body*

*temperature, heart rate (HR), and skin temperature were monitored using wearable sensors, and physiological indexes were computed. In addition, perceptual strain index (PeSI) and psychomotor vigilance task (PVT) response times were recorded. Statistically significant increases in physiological parameters were observed under hotter conditions. The study identified statistically significant correlations between the PeSI and the physiological strain index and between PeSI and HR. Perceptual scores were consistently higher than the values derived from physiological measurements, suggesting a greater subjective experience of heat strain. The PVT response times were higher on the hotter day, reflecting increased cognitive strain due to heat exposure. The study highlights the critical impact of heat stress on TWs, with statistically significant increases in physiological and cognitive strain under higher temperatures. Future research should focus on real-world applications of heat strain monitoring.*

# *Travail par fortes chaleurs et périodes de canicule*

S. Das and E. Somanathan.

**Heat causes large earnings losses for informal-sector workers in India.**

ENVIRONMENTAL RESEARCH LETTERS. 2024;19(12).

https://doi.org/10.1088/1748-9326/ad7da4

*Heat reduces labor productivity and output in formal manufacturing but little is known about its impacts on the earnings and welfare of workers in the informal sector that comprise 82% of the labor force in low-income and lower-middle-income countries. This study reports the results from daily surveys of nearly 400 workers in two slums in Delhi for a month in the summer of 2019. Every degree Celsius increase in wet bulb temperature was associated with a fall in gross earnings of 13(+/- 3.5) percentage points, a fall in earnings net of work-related expenditure of 19(+/- 4.5) percentage points, an increase in the self-reported probability of sickness of the worker or a family member of 6(+/- 0.5) percentage points, and a decrease in the probability that a worker went to work of 2(+/- 0.5) percentage points. Net earnings were 40% lower during the two heatwaves that occurred during the study period. Over 320 million informal-sector workers in low-income and lower-middle-income countries are currently exposed to temperatures similar to those observed in this study.*

J. W. Specht, S. Garcia, D. H. Wegman, J. Glaser, Z. J. Schlader and F. T. Amorim.

**Heat strain in road construction workers during the summer in New Mexico: a preliminary study.**

ANNALS OF WORK EXPOSURES AND HEALTH. 2024.

https://doi.org/10.1093/annweh/wxae097

*In the summer season, road construction workers perform physically demanding tasks outdoors, placing them at greater risk for exertional heat illness conditions. Assessing core temperature (Tcore) is critical as it serves as a key indicator of heat strain and helps to estimate the risk of heat-related illness. Despite the increased risk of hyperthermia, previous research has not assessed Tcore in road construction workers in the United States during summer work. Purpose: To report heat strain and environmental heat stress in a pilot study of road construction workers during work in the summer. Methods: Seven male road construction workers in New Mexico were observed performing physically demanding work during a summer work shift. Environmental heat stress (heat index [HI], dry/wet bulb temperature, and relative humidity), Tcore, and skin temperature (Tskin) were measured continuously at a single job site throughout the workday. Hydration was assessed pre- and post-shift via measurements of urine specific gravity (USG) and changes in body weight. Results: The peak HI recorded throughout the workday was 34.1 degrees C, corresponding to a "warning" heat risk level according to the Occupational Safety and Health Administration Heat Safety Tool App. Two of seven (29%) workers reached a peak Tcore of greater than 38.0 degrees C, and 4 (57%) began the work shift dehydrated, indicated by a USG >1.020. Conclusions: Findings from this pilot study suggest that road construction workers may begin their shifts dehydrated and some experience moderate hyperthermia while performing physically demanding work in hot environmental conditions.*

S. P. Parajuli, T. Biggs, F. de Sales, M. A. Z. Perez, C. He, C. Jones, C. Thompson, N. L. Galvez, H. Ciborowski, T. Quintino, C. Di Napoli, A. Montazar, T. H. Yazdi and M. Soucier.

**Impact of irrigation on farmworker's heat stress in California differs by season and during the day and night.**

COMMUNICATIONS EARTH & ENVIRONMENT. 2024;5(1).

https://doi.org/10.1038/s43247-024-01959-7

*Farmworkers, the frontline workers of our food system, are often exposed to heat stress that is likely to increase in frequency and severity due to climate change. Irrigation can either alleviate or exacerbate heat stress, quantification of which is crucial in intensely irrigated agricultural lands such as the Imperial Valley in southern California. We investigate the impact of irrigation on wet bulb globe temperature (WBGT), a key indicator of heat exposure in humans, using a validated high-resolution Weather Research and Forecasting (WRF) regional climate model, during day and night and in different seasons. We find that irrigation reduces WBGT by 0.3-1.3 degrees C during the daytime in summer due to strong evaporative cooling. However, during the summer nights, irrigation increases WBGT by 0.4-1.3 degrees C, when a large increase in humidity sufficiently raises the wet-bulb temperature. Urban and fallow areas adjacent to cropped fields also experience increased heat stress due to moisture advection from irrigated areas. Our results can inform heat-related policies in agricultural regions of California and elsewhere.*

D. Leddin, P. Sinclair, H. Singh and R. Sherman.

**Template of a climate sustainability plan for medical professional organizations: the Canadian Association of Gastroenterology example.**

JOURNAL OF THE CANADIAN ASSOCIATION OF GASTROENTEROLOGY. 2024.

https://doi.org/10.1093/jcag/gwae051

*Environmental change is underway and has the potential to adversely affect digestive health. Professional medical organizations have an important role to play in addressing the challenge. An important initial response is the development of a sustainability plan for the medical organization. There are no standardized criteria as to what should be included in such a plan. We have proposed 12 key components that should be contained in sustainability plans for medical organizations. We describe how these were developed for the Canadian Association of Gastroenterology (CAG) and plans for future implementation. We hope that the CAG plan may serve as a template to assist peer medical organizations optimize their response to the climate crisis. Our environment is changing because of global warming and pollution. A changing environment is bad for health. Doctor's organizations are moving to educate healthcare workers on how to respond. The first step is to develop a plan, and we have outlined what should be contained in a plan so that it is as effective as possible. We hope that this will help other doctors' organizations move to meet the challenge of environmental change.*

H. T. Wang, K. K. Lei and Z. D. Cheng.

**Thermal environment and waste heat recovery of high-radiant heat workshop.**

JOURNAL OF BUILDING ENGINEERING. 2024;98.

https://doi.org/10.1016/j.jobe.2024.111014

*The high temperature of the high radiant heat reservoir workshop, the poor working environment of workers, and the long-term heat stress will hinder the brain power and cardiac function, which is an important environmental factor that causes unsafe behavior, and the waste heat loss in the workshop is serious. Taking the heat reservoir power of 10 kW as the research object, the role of heat shield under different water flow conditions in the waste heat recovery and reduction of workshop temperature was analyzed. The results show that when the mass flow rate of cooling water is 0.7 kg/s, the average indoor temperature is 22.39 degrees C, the cooling range is 39.14 %, and the waste heat recovery efficiency is 84.4 %, and the heat recovery effect is obvious. At the same time, the fitting relationship between outlet water flow and water temperature is obtained. The research results can provide a reference for the improvement of the thermal environment and waste heat recovery and utilization of the actual high-radiation heat workshop.*

# *Actualités décembre 2024*

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

*Réchauffement climatique : la chaleur frappe davantage les jeunes que les personnes âgées*. Letelegramme.fr, 13 décembre 2024

*Extreme heat puts garment factory workers at risk, study shows*. Reuters.com, 08 décembre 2024

- **EPI, matériaux protecteurs/refroidissants**

*Your Comprehensive Guide to Flame-Resistant Clothing*. Marketwatch.com, 31 décembre 2024