

EXAMINATION OF THE EFFECTS OF GLOBAL WARMING ON WORKERS IN THE CONSTRUCTION INDUSTRY

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Abstract

This research analyses and presents climate change processes in Europe and Hungary, with particular regard to the increase in the intensity and frequency of summer heat waves, which in recent years have posed a significant additional occupational health and safety risk in the construction industry, as well as increased heat stress for workers. The Hungarian occupational safety legislation currently only sets out a limited number of detailed employer obligations regarding the management of extreme temperature conditions, so in light of the current climate impacts, it may be justified to go beyond the existing regulations and develop a stricter regulatory framework. Accordingly, in the empirical phase of our research, we use instrumental measurements to investigate the actual microclimate parameters at a representative construction site, as well as their physiological and performance effects on workers.

Keywords: occupational safety, EHS, construction industry, climate change

1. Introduction

According to a report by the World Health Organization (WHO), the global average temperature in 2022 was +1.15 °C higher than the average for the years 1850–1900. According to instrumental records, the period between 2015 and 2022 was the eight warmest years since 1850. The concentrations of the three main greenhouse gases (carbon dioxide, methane, and nitrous oxide) reached their highest observed levels in 2021, the most recent year for which reliable global values are available from the data series starting in 1984. The annual increase in methane concentrations between 2020 and 2021 was the highest ever recorded. Real-time data from certain locations already show that the levels of the three greenhouse gases continued to rise in 2022. In Hungary, based on data from HungaroMet Magyar Meteorológiai Szolgáltató Nonprofit Zrt., Figure 1 shows that the average temperature began to rise rapidly (WEB_1, 2024). In order to control the drastic rise in temperature, the European Union has set national emission reduction targets for member states for 2030, compared to 2005 as the base year. Under the regulation, Hungary must achieve a reduction of at least 18.7%. This means that emissions must be reduced from 47.8 million tons of CO₂ equivalent to 38.9 million tons of CO₂ equivalent.

Regulation (EU) 2018/841 requires all Member States to ensure that emissions do not exceed the above-mentioned equivalent for the periods 2021–2025 and 2026–2030.

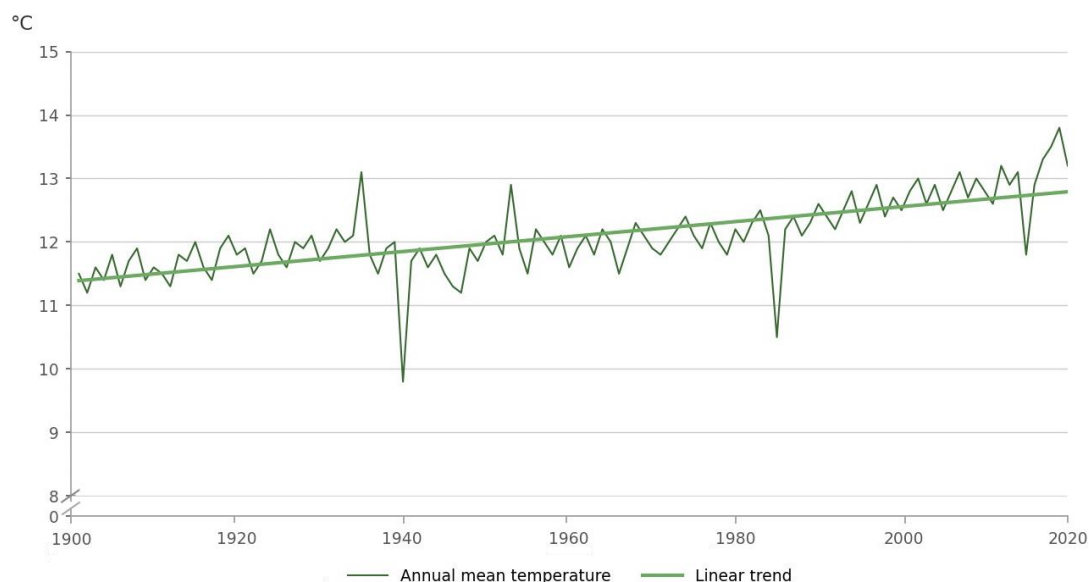


Figure 1. Annual average temperature increase in Hungary (WEB_2, 2024)

In December 2019, the European Council approved the target of making the EU climate neutral by 2050 and reducing net greenhouse gas emissions by 55% by 2030. On July 15, 2021, the European Commission published a package of proposals entitled “Aiming for 55%”, which aims to bring EU legislation into line with the EU’s 55% net emission reduction target for 2030.

Hungary’s greenhouse gas emission reduction targets are in line with EU and international commitments. Hungary has set itself the goal of achieving climate neutrality by 2050. Hungary has also confirmed this goal in Act XLIV of 2020 on climate protection. This means that emissions in 2030 must not exceed a gross equivalent of 47.5 million tons of CO₂, which means that emissions must be reduced by 16.7 million tons of CO₂ equivalent from 2021 levels.

In addition to reducing greenhouse gas emissions and improving greenhouse gas intensity, it is also of paramount importance for Hungary to promote adaptation to the effects of climate change. At EU level, the European Commission’s “EU Strategy on Adaptation to Climate Change (EU Adaptation Strategy)”, adopted in April 2013, is the guiding document for Member States’ adaptation policies (Kjellstrom, 2009).

The currently adopted and valid adaptation policy in Hungary is the second National Climate Change Strategy (NÉS-2) for the period 2018–2030, which provides an outlook for the period up to 2050. National Adaptation Strategy (NAS) module, which sets out a vision for adaptation and comprehensive and specific (strategic) objectives for domestic climate adaptation [23/2018. (X. 31.) OGY határozat, 2018].

2. Biological and physiological processes of thermoregulation

Global climate change has many effects, primarily leading to a warmer climate, which is exposed to increasing heat and solar radiation, especially when working outdoors. Vectors carrying infectious

diseases are appearing or increasing in number, as are allergens and toxins caused by flora and fauna. The frequency of extreme weather events is also likely to increase. The associated risks to workers pose particular challenges for occupational safety and health. The primary goal is to ensure assessment standards and protective measures adapted to the effects of climate change. The external ambient temperature is a factor that closely affects plant and animal organisms, including humans, whose tolerance to heat stress is ensured by our internal thermoregulation. Today's changing climate conditions, increasing industrial processes, and the demand for increased productivity place a growing burden on both employers and employees, making the establishment of an appropriate workplace temperature crucial for both parties. In addition, it is important to have a good understanding of the legal environment and to apply it correctly (Kjellstrom, 2009).

3. The importance of temperature control

Humans are homeothermic creatures, meaning that their body temperature re-mains constant within a narrow range regardless of the external ambient temperature (Farkas, 2016). Our body temperature is not evenly distributed throughout the body. Strictly speaking, core body temperature is the temperature of the heart, but in a broader sense, it refers to the temperature of the internal organs, which is generally accepted to be 37 °C. Its value fluctuates daily, following a circadian rhythm: it is lowest upon waking (35.8 °C) and highest in the late afternoon (37.5 °C). The mantle temperature is the temperature of the skin and subcutaneous connective tissue, as well as the distal parts of the limbs. At normal external, so-called thermoneutral temperatures (27–31 °C), the skin temperature of a naked person is about 4-5°C lower than their core temperature. When clothed, the same thermoneutral zone is 21–23°C. At lower ambient temperatures (23 °C), skin temperature is approximately 10 °C lower, while at ambient temperatures above 30 °C, skin surface temperature levels out at around 34-35 °C. Since the reduction in body hair in modern humans (*Homo sapiens sapiens*) represented a fundamental change in thermoregulation compared to our ancestors, wearing appropriate clothing has become essential for the survival of our species.

The heat generated during the body's daily functioning is responsible for the positive heat balance. The main substrates of the body's metabolism are glucose, proteins, and fats, which release heat during the formation of their end products. In an adult human body weighing one kilogram, approximately 4 kJ of energy is released per hour as a result of metabolic processes, which increases the body's temperature by approximately 1 °C per kilogram per hour. During intense physical work, heat production can reach 40 kJ/hour. In order to maintain a constant body temperature, 4–40 kJ of energy must be released into the environment per hour [Parliamentary Resolution 23/2018 (X. 31.)]. The above clearly illustrates that the constant and precise interaction of heat loss and heat production in the human body is necessary for the normal functioning of the body, i.e., the sum of heat production and heat loss must be zero.

4. The body's response to an increase in external environmental temperature

The main goal of thermoregulation is to maintain a constant core temperature and, with it, the temperature of the internal organs. When the external ambient temperature rises, our body responds with a voluntary response via the cerebral cortex and an involuntary response via the activation of the hypothalamic thermoregulatory center.

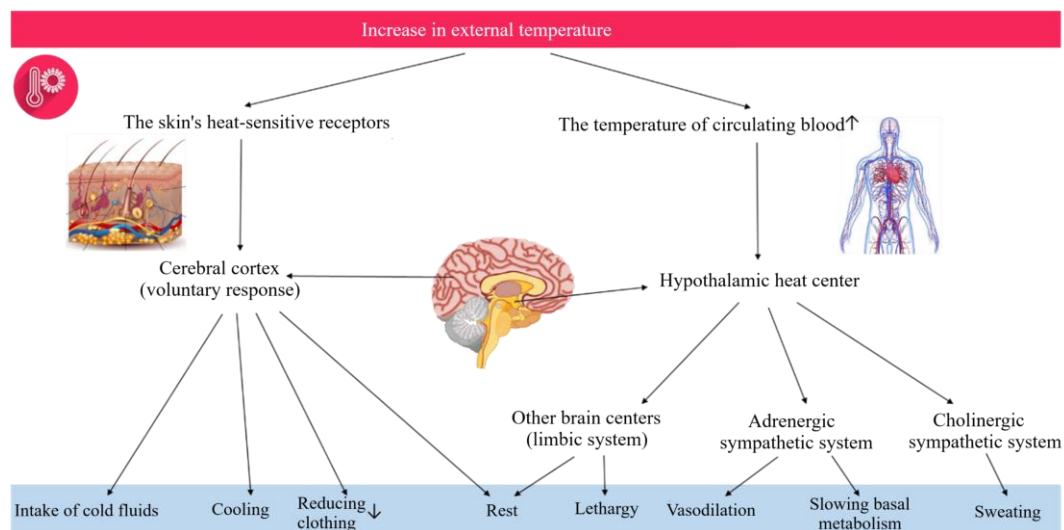


Figure 2. Voluntary and involuntary responses of the body to an increase in external temperature
(Own figure based on Fazekas et al., 2009)

When the temperature rises, the stimulus generated in the heat-sensitive receptors in the skin reaches the cerebral cortex, where the cerebral cortex responds to the body by telling it to lower its temperature, i.e., to increase heat dissipation. At this point, we feel the need to cool our body, drink cool liquids, remove some clothing, and sit down for a few minutes. At the same time, involuntary compensatory mechanisms controlled by the hypothalamus activate the limbic system and the adrenergic and cholinergic sympathetic systems, which primarily work to reduce metabolic activity, thus achieving optimal heat dissipation. During this process, the blood vessels dilate, cooling the temperature of the circulating blood, lowering blood pressure, slowing down the basal metabolic rate, and triggering sweating (Fazekas et al., 2009). Approximately 85% of the heat generated by heat stress is lost through the skin (sweating), 10% through respiration via the lungs, and the remaining 5% through urine and feces (Farkas, 2016).

A person's tolerance to heat stress also depends greatly on the humidity of the environment, as higher ambient temperatures are more difficult to tolerate when the humidity exceeds 70%. Hyperthermia occurs when the body is unable to dissipate heat adequately. We must pay particular attention to adequate heat regulation in individuals working in hot environments such as factories, kitchens, bakeries, smelters, mining facilities, and agricultural work in extreme heat. Those who have to wear multi-layered protective clothing for their work, such as firefighters and soldiers, are also at risk. The clinical symptoms of hyperthermia include, in milder cases, rapid, shallow breathing, profuse sweating, and a rapid but weak pulse. The skin feels warm because the blood vessels dilate to increase heat loss. After a while, the skin becomes dry because the body is unable to cool itself through sweating. Other symptoms include nausea and vomiting, headache, dizziness, fainting, low blood pressure, aggression, and confusion. The elderly, infants, and young children are more prone to dehydration and hyperthermia. Chronically ill people, obese people, and people with cardiovascular problems also tolerate heat less well, partly because they may be taking medications that further worsen their condition (for example, because they can cause low blood pressure or are associated with an increase in core body temperature).

5. Legal aspects of establishing the ideal workplace temperature in Hungary

The Occupational Safety Act [Act XCIII of 1993 on occupational safety, Section 33(1)] stipulates that a suitable environment is necessary for work. This means that workers must be provided with sufficient air of appropriate quality (Act XCIII of 1993 on occupational safety).

One of the implementing regulations of this law (Decree 4/2002 (II.8.) SZCSM-EÜM) specifies the specific occupational safety requirements [Decree 4/2002 (II.8.) SZCSM-EÜM]. The cited decree stipulates what the air temperature should be for different types of work (e.g., mental, physical). There are regulations for both the cold and warm seasons. The regulations for the latter season are as follows:

- Mental work 21–24 °C;
- Light physical work 19–21 °C;
- Moderately heavy physical work 17–19 °C;
- Heavy physical work 15–17 °C.

The temperature specified in the legislation does not refer to the value measured by a simple thermometer, but also takes into account the effects of heat radiation and air movement, which are used to correct the measured temperature value.

5.1. Employees exposed to heat stress

Within the framework of organized work, an increase in ambient temperature can be a factor affecting employees in any field of employment, which can cause sudden deterioration in closed workplaces and during outdoor work processes, heat stress, but occupational safety experts place greater emphasis on workers in the latter sectors. The stress experienced by workers in enclosed workplaces can be similar to that experienced by workers in outdoor activities, which have received special attention. The effects of climate change can alter the natural environment of a given geographical location, and occupational safety experts must face new risk factors. The health of workers can deteriorate dramatically when exposed to heat, but the extent of this can be determined by age or pre-existing health conditions. These factors must be taken into account when determining measures or individual protection.

Most construction work is considered to be outdoor work, as workers perform intensive physical labor while being directly exposed to sunlight and heat, as in other sectors. Employees must perform to the best of their professional ability and exertion in the construction industry, even in extreme climatic conditions. Extreme weather conditions do not exempt employers and employees from specific safety requirements, so personal protection can also cause a significant burden. Often, the machinery and lifting equipment used in the construction industry are not equipped with adequate air conditioning, and in this case, heat stress can cause health problems even without strenuous physical activity.

Employees working in enclosed workspaces are also exposed to the stresses caused by heat stress. Legislation on enclosed workplaces specifies ideal temperature conditions, but workers often have to work in outdated buildings where artificial air conditioning is not possible. The risk of heat stress can be increased by humidity levels.

5.2. Other reactions triggered by climate change

The human body's defense mechanisms can trigger a number of reactions to temperature and climate change. In most cases, the body's response is reversible, but in the field of occupational safety, additional risks must also be taken into account, such as secondary injuries or the development of a harmful condition or illness.

- Heatstroke;
- Rhabdomyolysis;
- Heat syncope;
- Heat cramps;
- Heat rash;
- Sunstroke;
- UV radiation from the sun (eye and skin damage);
- Infectious diseases;
- Allergens and toxins.

5.3. Accident risks in case of increased heat stress

The first signs of heat exposure may include sweaty palms, perspiration, dizziness, slowed reflexes, or fogged glasses, which increase the risk of injury. Even in a 10-minute interval, heat can reduce workers' concentration, alertness, and attention, and signs of fatigue may appear as a result of their bodies slowing down, which increases the risk of accidents (Yi and Chan, 2017).

A decline in attention and alertness is unacceptable for workers performing high-risk tasks, such as those operating machinery or lifting equipment. In the construction industry, a decline in cognitive abilities can also pose a risk to the scope of work.

The effect of temperature can be exacerbated by the amount of sunlight, as the physical abilities of workers exposed to sunlight can change suddenly, increasing the risk of injury. The strain caused by heat stress can be reduced by adopting employer measures and work organization decisions. In practice, the sunny period can be bridged by dividing working hours, during which the employee is forced to perform the tasks assigned to them in the morning or late afternoon and evening hours. When making this decision, it is also advisable to consider the risks associated with splitting working hours, as during this period employees' reactions slow down, visibility decreases, and concentration declines (EU-OSHA, 2023).

Due to the high temperatures, it is also necessary to examine whether the risks arising from the technology can be avoided, as the temperature conditions may cause a fire hazard from certain materials or fermented waste. The magnifying effect of lenses, which can focus the sun's rays and act as an ignition source, must also be taken into account. Electrical equipment may also overheat, and pressure may increase in machines.

It is advisable to take the above risk factors into account when organizing work or planning a time frame for implementation, so that occupational safety experts and employers can take measures to address as many potential hazards as possible.

5.4. Monitoring heat stress

Employers must take technical and organizational measures to address the risks of heat stress. A prevention plan can reduce the stress caused by heat stress, but weather forecasts must also be monitored. Temperature values must be recorded in advance, heat warnings must be monitored, and work schedules may also need to be adjusted (Varghese, 2018).

The primary solution is to establish collective protection, followed by the reorganization of vulnerable workers and the reduction of risks to them. If collective protection cannot be implemented to reduce heat stress, personal protective equipment may be a solution, taking into account technological hazards and risks arising from climatic conditions.

Main contractors or contractors are often forced to reschedule work, so even the temperature can be an obstacle to overcoming heat stress.

The preventive measures outlined above must be implemented at an early stage, regardless of whether a heat alert has been issued. Extreme weather conditions must be monitored and an emergency plan may be necessary. The plan should include symptoms related to heat stress and define first aid options (EU-OSHA, 2023).

For construction sites, general contractors and their subcontractors must prepare a “Variable Workplace Risk Assessment” for their assigned tasks. The risk assessment must be continuously reviewed, often in accordance with NNK regulations, due to heat alert levels. Heat alerts are issued in all countries by designated authorities when average temperatures are higher than normal or when the average temperature is expected to exceed 30 °C. In Hungary, heat alerts can be issued by meteorological services, disaster management authorities, and the NNK. At the first level of the high temperature warning, the daily average temperature is expected to be between 25 and 27 °C (for at least one day) in an area corresponding to at least one average Hungarian county.

A second-level warning is issued if the daily average temperature is expected to be between 27 and 29 °C in an area corresponding to at least one average Hungarian county (for at least one day).

At the highest level of the heat warning, the daily average temperature is expected to exceed 29 °C in an area corresponding to at least one average Hungarian county (for at least one day) WEB_3, 2024).

6. Organizational measures

Employers must create the ideal working environment as defined by law, therefore technological tasks must be modified where possible and the possibility of collective protection measures must be examined, with the ultimate goal of reducing the metabolic heat of employees. If the pace of tasks or technical measures do not lead to results, implementation must be suspended.

Employers must take heat alerts and heat waves into account and take organizational measures accordingly. During management tasks, the designated person or company manager may limit the amount of time employees spend in the heat and increase the amount of time spent in a cool place for regeneration/acclimatization. The essence of the decision is to encourage employees to regenerate.

During the design phase, the plan chapter compiled by the Safety and Health Coordinator must include a proposal for insulating hot surfaces or covering them with low-heat-emission materials (e.g., aluminum), or the use of paint that reduces the amount of heat radiated from the heated surface into the working environment. The use of machinery is an essential part of construction processes, and here we must ensure that the heat generated by the machinery is reduced, for example by ensuring that the equipment cools down before it is used again. Numerous burns and overloads can lead to unexpected risks.

For structural construction, bricklaying, tiling, facade construction, paving, and road surfacing tasks, it is advisable to provide shade for workers to reduce the amount of heat coming from sun-exposed areas, which can be achieved using mobile devices or reflective stretched canvas.

It is advisable for contractors to organize their employees' working hours in advance, as time spent in the heat must be minimized. It may therefore be important to introduce flexible working arrangements, such as job rotation or, where possible, relocating workers to cooler parts of the building. Employers should consider adjusting daily or seasonal working hours to avoid periods of high temperatures and UV exposure. In addition, physically demanding work, such as manual material handling, even to upper floors, should be taken into account and these work processes should be

scheduled for cooler periods, such as early morning and late evening. Efforts should be made to work on the ground floor to minimize climbing stairs or ladders. Work should be organized so that employees do not work alone, or if they do have to work alone, they should be supervised and ensured that they can easily call for help if necessary.

Employees should try to schedule breaks into their daily work that they can arrange themselves. In this case, employers should prohibit the accumulation of breaks during hot weather, which would result in a reduction in working hours.

The duration of rest periods must be determined by employers, but the age and physical condition of employees, the degree of cooling, and the necessary replenishment of fluids with minerals must be taken into account.

Employers must allow for rest and breaks to drink water if employees feel uncomfortable due to the heat, and may therefore adjust rest periods to longer intervals to give the body a chance to release excess heat. Employers should consider the fitness of their employees and provide lighter work and longer, more frequent rest periods for younger or older workers. More frequent rest periods may be important when temperature, humidity, and solar radiation are high, when there is no air movement, or when employees wear protective clothing or equipment for heavier work.

Even in the legal environment, there is no definition of what constitutes a sufficient break, as each employee has a different tolerance for external temperatures. In order to ensure sufficient breaks, it is advisable to extend the hourly rest periods specified in the legislation so that employees can consume cold drinks or cool down. In the construction industry, it is quite difficult for contractors to keep to the schedule in the event of unexpected events or even a heatwave. When progressing through schedules, we often ignore unexpected weather conditions or fail to factor them into the schedule, so we do not change the pace of work to make the work easier and reduce physical strain.

6.1. Forecasting and monitoring heat effects as an employer measure

All employers must draw up rules and procedures on how to act in the event of a heatwave and what tasks employees must perform in such cases. These can even be used as emergency scenarios. The procedural instructions must include a person trained in first aid. Both supervisors and employees must be made aware of the early signs and symptoms of heat-related illnesses and how to apply the relevant first aid procedures.

It is advisable to implement a peer support system in the workplace, whereby employees are responsible for monitoring early signs and symptoms of heat intolerance in themselves and their colleagues, such as weakness, unsteady gait, irritability, confusion, skin discoloration, or general malaise.

The body is able to adapt to a new climate if it is acclimatized gradually. The essence of the acclimatization process is the principle of gradualness, whereby the body adapts to physiological exposure to warmer environmental temperatures in stages.

During acclimatization, sweating begins earlier and to a greater extent, and electrolyte loss remains low. This process stabilizes the body's circulation, physical activity, low heart rate, and core temperature. The entire process can take up to a week, but some workers may need a longer cycle (Périard et al., 2015).

Heat acclimatization can be lost gradually during a long absence or a long weekend because the worker is no longer exposed to heat. This phenomenon is called a decrease in heat tolerance. Heat tolerance can be restored through a repeated acclimatization process, so it is not advisable for employees to start working in a very hot environment during the first few days.

Acclimatization processes should be planned so that employees only reach half of their usual workload in the first few days, which should be the solution for new employees. The workload can be gradually increased to the full extent in the following days.

The extent of the acclimatization process may also depend on physical characteristics, as some employees are more physically fit and can tolerate the effects of heat stress better than others. There are many well-trained employees who are less physically fit or suffer from some kind of chronic illness, in which case the acclimatization process is slower or not feasible. Before starting acclimatization, it may be necessary to consult with occupational health professionals, as the process can be influenced by various medications, such as antidepressants, amphetamines, diuretics, antispasmodics, and antihypertensives.

Employers should organize the time spent in hot conditions for employees according to the principle of gradualness, which can be 7 to 14 days according to Table 1.

Table 1. Acclimatization schedule (EU-OSHA, 2023)

Heat acclimatization process for new hires or long-term absentees	
Day 1	No more than <u>20%</u> of the workload in hot conditions on the first day.
Day 2	<u>20%</u> increase on subsequent days after the first day
Additional Employee acclimatization schedule (based on an 8-hour period)	
Day 1	Up to <u>50%</u> of the normal duration of activities performed in heat exposure
Day 2	Up to <u>60%</u> of the usual duration of activities performed under heat exposure
Day 3	Up to 80% of the normal duration of activities performed under heat stress
Day 4	Up to <u>100%</u> of the normal duration of activities performed under heat exposure

The cycles shown in the table can only be successfully completed if the employer ensures, through appropriate organization and supervision, that acclimatization processes are carried out for new recruits, employees returning from long-term absence, or employees who work continuously without heat exposure. The employer must follow the 14-day process and may need to consult with employees or their representatives, as a longer cycle may be necessary for some employees to achieve the desired result.

6.2. Personal protective equipment and its limitations

Today, efforts are being made to ensure that employees can wear appropriate work clothes even during prolonged periods of hot weather, with the primary focus on good ventilation and breathability. This encourages employers to provide their employees with work clothes suitable for a variety of weather conditions, which can be costly. In order to reduce the risks caused by extreme weather conditions, employers must provide protective clothing or equipment to employees when temperatures rise to extreme levels. Among protective clothing, solutions that can maintain the ideal temperature for the employee's body are helpful. Solutions currently available on the market include clothing with heat-conducting fluid, ice vests, heat-reflective protective layers, and battery-powered air-cooled versions.

The purpose of the solutions listed above is to maintain the body's core temperature at the ideal value of around 37 °C, because the body can cool itself down slowly. These solutions do not eliminate the need for rest periods, but they do help maintain physical activity, alertness, and concentration during work (EU-OSHA, 2023).

However, mandatory work clothing or individual protection solutions may have limitations. The employer's primary consideration will be economic issues. Currently, in terms of heat exposure, the employer can decide whether to provide individual protection that is appropriate for the weather conditions or to organize the work accordingly. If the latter is chosen, the limitations of the individual protective equipment must be taken into account, because the aforementioned ice vests are inexpensive, but their temperature cannot be regulated and they often do not remain cool long enough to be practical. Since every employee has a different sensitivity to heat, employee cooperation is essential before purchasing individual protection, because if the cooling system is too cold, it can reduce the employee's comfort or even cause further illness. Employers generally entrust employees with the proper operation of personal protective equipment, which can cause additional stress due to employee inattention. Many wearable personal cooling systems are too heavy or cumbersome to be practical for use in the workplace.

Some special working conditions should also be mentioned. When removing asbestos, workers must wear special personal protective equipment during the work process and follow strict decontamination procedures. If personal protective equipment is uncomfortable or heavy, it can contribute to an increase in body temperature, so attention must also be paid to the heat stress caused by such protection.

If heat stress is felt, employees should be encouraged to remove their personal protective equipment, but in this case, work should be stopped and the protected area should be vacated. This allows the employee to get rid of the excess heat generated by the protective equipment. The removed protective equipment must be dried before reuse. If this is not possible or the technology does not allow it, new personal protective equipment must be provided to the employee. The legal requirements for personal protective equipment may prevent individual employees from implementing the former solution if this option exposes them to the risk that the personal protective equipment protects them from.

In these situations, employers are required to ensure careful work organization, which promotes a slower work pace and the formation of multiple teams of employees, thus facilitating more frequent shifts for those working in such environments and allowing for longer rest periods.

Employers are required by law to provide personal protective equipment and work clothing to employees, but the regulations do not specify the quantity to be provided. It is therefore advisable to provide rooms for drying personal protective equipment so that it can be reused, while providing new personal protective equipment for the transitional period.

When reviewing the workplace risk assessment, it is necessary to determine whether the technological process can be automated or, if an alternative work system is possible, what more advanced personal protective equipment can be obtained that is easier or more comfortable for the employee to wear. Comfort is also important because, when exposed to heat, employees may loosen their protective equipment or clothing, thereby compromising the level of protection for which the protection level was determined. In many cases, employers, taking all safety requirements into account, equip employees with too much personal protective equipment, which can cause additional strain. It is therefore advisable to review the processes and even specify complex personal protective equipment. In the case of complex solutions, the manufacturer's specifications must be taken into account, as it is often only possible to achieve the appropriate combination (compatibility) with their own products. As with all individual protection, the possibility of collective protection must be given priority.

6.3. The importance of hydration

When an employee works in a hot environment, their body reacts to the change by sweating, thereby losing salt and water. As the body has suffered a loss, we can replenish the lost minerals by hydrating,

which also provides salt. In the summer heat, physical activity can require up to 1 liter of fluid replacement per hour on average.

An unlimited supply of cool drinking water at around 10–15 °C must be provided at the work site, and employees must be instructed to replenish fluids every 15–20 minutes during working hours. Fluid replacement may be necessary even if the employee does not feel thirsty. Employees who have undergone the acclimatization process sweat less and therefore lose less salt. For them, the amount of salt replenished through daily meals may be sufficient to maintain their electrolyte balance.

Employees whose employers have not implemented acclimatization processes may be more prone to sweating, in which case they need to consume meals with a higher than usual amount of salt. Meals should not be salted, but the amount should be increased minimally. Salt tablets taken with water during meals are not a sufficient solution because they are absorbed slowly. Excessive salt intake raises body temperature and can increase sweating, thirst, and in many cases cause vomiting. Excessive salt loss, which also depends on the individual and when it occurs, can contribute to general weakness, diarrhea, and vomiting. In more severe cases, it can cause serious nervous system disorders, so recognizing it in the construction environment is essential. Employees are recommended to consume 2.5–3 liters of water per day, and during work, their knowledge should be supplemented if they feel that they are losing fluids, as they are likely to be deficient in minerals, especially salt, which they need to replenish. Everyone needs small amounts of good quality salt. It is best to choose sea salt instead of traditional rock salt, and unrefined sea salt at that. The composition of sea salt is similar to that of our blood serum, thus supporting the balance of our body. Unrefined sea salt even contains microalgae, and we know that algae contain minerals in organic compounds, which means they are better absorbed by our body.

It is possible to replenish the body fluids lost through sweating with drinks developed to replenish electrolytes. The advantage of these drinks over cool drinking water, as defined by law, is that they can also be given as protective drinks and replenish electrolyte loss. The current solution also has its limitations because manufacturers indicate the daily allowable amount on their products, so it can only serve as a supplement.

Isotonic drinks can be useful for people who are physically active, but it should also be taken into account that they can lead to excess salt or sugar intake in the diet. Natural fruit juice, even in a diluted form, can also be a solution, as it can be given as a protective drink. Isotonic drinks suitable for salt replacement for employees are available in various grocery stores or even nutritional supplement stores. Employers can even consider purchasing them, as they have the option of providing protective drinks that are also suitable for employees with diabetes. Isotonic sports drinks often contain caffeine or taurine to enhance athletic performance, which may be a disqualifying factor for employees when it comes to providing protective drinks, as drinks containing these ingredients would not be allowed to be consumed in the workplace because they dehydrate the body and have other harmful health effects.

Many employers are unaware of the effects of isotonic drinks and often only pay attention to the more favorable prices of mineral waters displayed in stores, without considering the salt content of the product.

6.4. Regeneration outside working hours

Employers face numerous risks during working hours in order to create the ideal working environment, technology, and work organization for their employees to ensure safe and healthy working conditions. When exposed to heat, it must be taken into account that employees may not be able to spend their rest periods (outside working hours) relaxing sufficiently. In many cases, employees do not have air-conditioned rooms in their homes, which often overheats, shortening their restful sleep and recovery time.

In such cases, the concept of fitness for work is compromised because the employee cannot be employed during the next day's shift.

Sleep deprivation is more prevalent among employees who live in crowded urban environments and are subject to the above-mentioned factors. The employer's influence can only come into play if they are required to provide accommodation or rental housing for the employee. In this case, the employer must examine the conditions suitable for coping with heat waves and the conditions necessary for regeneration before signing the lease agreement. Based on the employer's decision, they can examine the amount of rest time and prioritize split shifts. They can also schedule tasks for cooler periods, avoiding the hottest hours of the day during heat waves and organizing additional work in the evening hours. When implementing split shifts, the employer must also examine where the employee can be provided with rest opportunities. The employee must be able to rest at home and may not perform any other activities, including a second job, during this period. Since the employer has no control over the rest periods and conditions between shifts, only appropriate consultations and training can lead to solutions, where the employer must ensure that the employee is fit for work. The employer may be justified in expecting employees to be fit for work if they have been forced to provide accommodation due to the above split shifts.

A significant proportion of construction workers are unskilled or semi-skilled labourers earning close to the minimum wage. For those supporting a family on such income, air conditioning their home is rarely financially feasible. A further vulnerable group consists of workers who, during the construction period, spend their afternoons and evenings in workers' accommodation away from their families. In these cases, it is extremely rare for the employer to provide air-conditioned lodging. As a result, adequate rest and recovery may be compromised as early as the third or fourth consecutive day of a heat wave. It should be noted that for this group the critical risk period is approximately two and a half months, from mid-June to the end of August. Employers and occupational safety professionals must specifically consider these circumstances when planning preventive measures and work organisation, as the lack of adequate rest outside working hours can significantly increase the risk of heat-related illness and accidents at the workplace.

6.5. Consultation with employees

Decisions taken to mitigate the risks of working in heat must first be discussed with the employees or their representatives.

If several companies are working on the construction site, the main contractor or investor must consult with them within the framework of joint cooperation in order to find out who is responsible for what and how they can work together to eliminate or minimize risks. Employees must be informed of the results of employer consultations, which must address the effects of additional stress caused by heat and the identification of hazards. Decisions must be made for employees on how to eliminate or minimize risks.

Information must be provided on the suitability and use of facilities such as living quarters, rest areas and cooling areas, as employees may feel that a given temperature-controlled room is not sufficiently cooled. Employees tend to use excessive cooling settings with a difference of more than 7–10 °C compared to the natural temperature.

6.6. The importance of occupational health services

Any remaining risks identified during preventive and control measures must be addressed, and employers are obliged to monitor the health of their employees. Occupational health professionals may have a significant obligation to provide information if they are involved in addressing heat stress-related problems.

The heat-related illnesses discussed in previous chapters, certain medications, and health conditions can make employees more susceptible to heat-related illnesses and may also affect how they are treated. Employees should be warned about these risks and may need to be monitored. Employers should coordinate ongoing monitoring with occupational health professionals, even during prolonged periods of hot weather, to monitor the health of workers. Employers may reassign employees exposed to heat stress or provide them with additional rest periods before any negative health effects occur. Employees must be informed and consulted about the purpose and description of any workplace and medical monitoring programs, as well as the benefits of participating in such monitoring programs and what they entail. The confidentiality of health data must be respected. The consent of each employee must be obtained before health surveillance is carried out. Employees must be informed about what health surveillance means, why it is carried out and how it is carried out. They must receive their individual results, which must be explained to them, ideally with the help of the occupational health service or occupational health physician.

6.7. Informing and training employees

The employer must set up a training program to be carried out by persons trained in occupational safety. This should ensure that workers potentially exposed to heat stress and supervisors are aware of the health effects of heat stress and the measures to be taken, as well as who to report unexpected events to. In particular, workers should be trained before starting work in the heat, in the form of information and instructions specific to the workstation or task, and the training should be adapted to the conditions in the work area.

For all affected employees, the instruction program should include appropriate verbal or written instructions in a language that the employee can understand. It is recommended that employers develop a written plan for the training program, which also includes a record of all training materials. The employer must inform all affected employees of the location of the written training materials and make these materials easily and freely available to the affected employees.

Information and training must also be provided to employees employed by subcontractors or other companies operating in the work area. Good coordination is key to protecting us all. All new and existing employees, as well as their supervisors, who work in areas where there is a significant risk of heat injury or illness, must be trained and kept informed about the technical and organizational measures specified for work in areas subject to heat stress, the dangers of heat stress, the relevant signs and symptoms of heat injury and heat damage (excessive strain caused by heat stress and occupational disease), the causes of heat-related illnesses, and steps to reduce the risk. These include drinking sufficient amounts of water and monitoring the color and volume of urine. In many areas of the construction industry, occupational safety specialists are still confronted with factors that affect fitness for work, such as drugs, alcohol, pre-existing conditions, and regular medication, which were not revealed in a fitness test. The tolerance to heat stress in the workplace must also be mentioned in relation to the dependence prescribed or developed by the specialist doctor listed above. Currently, food service units such as vending machines and even snack carts have appeared in construction areas. A significant proportion of workers consume

therapeutic drugs, alcohol, or caffeinated beverages to increase concentration and exertion, which can increase the risk of heat injury or illness by reducing heat tolerance.

The legal environment requires employers to have trained first aiders on duty in certain cases in order to provide early assistance, but employers must include general first aid procedures and workplace-specific first aid procedures as part of their training.

In the section on personal protection and work clothing, I explained that the risks associated with the technology do not necessarily allow for protective clothing and equipment to be worn loosely and easily, so attention should be paid to proper use. In most cases, employers are responsible for fulfilling the obligations prescribed by law for their employees, but employees must also be made aware of their responsibility to comply with appropriate working methods and control procedures.

Today's training must include the importance of immediately informing supervisors of any symptoms or signs of heat-related illness, either in themselves or in their colleagues, and calling for help if necessary.

There may be a misconception that someone who is "tough" is not affected by the regulations on protective drinks in relation to heat exposure and therefore becomes dehydrated before starting regular work. This misconception is dangerous and must be counteracted through educational efforts.

When we examine a construction site, the first person to supervise the contractors and direct the construction processes in the work area is the main contractor or the investor. In most cases, if we do not consider the subcontractor level, the main contractor has the legal authority to educate, coordinate, and supervise contractors in a given work area. These tasks and roles are defined by law, so the actual management tasks are performed by the construction manager or work supervisors alongside the safety and health coordinator, which is why their training must also cover temperature conditions and the effects thereof.

As with any risk that arises, one of the most important points is how to prevent heat-related illnesses and apply the preventive measures prescribed by the employer. The measures or even a safety and health plan must include technical and organizational measures as well as individual protection. Managers should be able to recognize the symptoms and signs of heat-related illnesses in themselves and others and, if necessary, be able to provide appropriate assistance. One of the main principles at the company I examined is that construction managers are trained as first aiders in the workplace, as they are able to take professional steps to provide assistance at an early stage. They can make recommendations to the general contractor's decision-makers, thereby modifying the intensity of the work and ensuring that regular breaks are taken.

Based on the training of employees in supervisory positions and the safety and health coordinator, contractors must be made aware of the importance of drinking enough water to stay hydrated and understand the dangers of drinks with diuretic properties.

Employees who are aware of the individual risk factors that extreme temperatures can cause may be employed in supervisory positions. They must understand the importance of acclimatization and the sudden heat waves that can result from the effects of climate change.

7. Summary

Employers must create the ideal working environment as defined by legislation, so technological tasks must be modified where possible and the possibility of collective protection measures must be examined, with the ultimate goal of reducing the metabolic heat of employees. If the pace of work or technical measures do not produce results, it is necessary to suspend work.

The summer heat waves observed in Hungary place a significant additional burden on employers, as greater emphasis must be placed on ensuring the health and safety of workers employed in the construction industry. In terms of the Hungarian legal and regulatory environment, Act XCIII of 1993 on occupational safety and joint Decree 4/2002. (II. 8.) SzCsM-EüM are the governing regulations. Employers must supplement the basic education and training documentation with strategies for preventing and, if necessary, treating heat stress, in addition to the aforementioned legal requirements. Accordingly, employers need to take continuous organizational measures to mitigate heat stress and work more closely with occupational health professionals. Workers in the construction industry can be introduced to the job through a multi-stage workload, known as acclimatization. Depending on climatic conditions, workers must be kept under constant medical supervision. When providing protective equipment, it is no longer sufficient for employers to analyze the risks associated with the technology in question; they must also examine the extreme temperature factors that occur in the construction industry. In addition to individual protection, the possibility of providing collective protection in the form of shade in construction areas must also be considered.

In many construction areas, deadlines will have to be postponed because, in many cases, employers will no longer be able to employ their workers in healthy and safe conditions due to high temperatures. In our work, we highlighted the extreme temperatures in the built environment and the fact that personal protective equipment can place an additional burden on workers. One safe solution to heat stress is to split or shift working hours to less sunny periods. However, this can also entail significant costs for employers, as they need to rent accommodation or rest containers close to the construction sites where employees can rest in a suitably temperate environment. In the future, providing drinking water as specified by law will no longer be sufficient, as physical work performed at temperatures above ~35 °C results in significant electrolyte loss, which can be replenished with mineral salts or sports drinks. Employers must also draw their employees' attention in their training program to the recovery time after work, when the employee spends their free time at home or in accommodation rented by the employer. Recovery time must be spent resting, and the possibility of a "second job" must be ruled out. However, it is important to note that employers currently have no legal authority in this regard. It is in the employer's interest to ensure ideal temperatures in the workplace, thereby promoting proper and adequate work performance, good employee performance, and employee satisfaction.

Today, dealing with summer heat waves is perhaps one of the most underestimated risk factors in the construction industry, but it could become one of the biggest challenges for construction projects in the future.

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