



# BUILDING HEAT RESILIENT DENTAL PRACTICES WITH OCCUPATIONAL HEALTH APPROACHES IN EXTREME TEMPERATURES

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## ABSTRACT

A significant part of the population worldwide is at high risk of diseases related to heat stress. The International Labour Organization estimates that by 2030, over 2% of working hours worldwide will be lost to heat, representing an economic loss of about \$2.4 trillion annually.

**The purpose** of this study is to investigate the impact of heat stress, in combination with mental and physical workload, on dental professionals and patients, to propose strategies for managing the associated elevated risks.

**Materials and methods.** Data were drawn from existing occupational health and safety regulations, peer-reviewed publications, and the applied practices of LOT-CONSULT, an established provider of occupational health and safety services. Additionally, insights were obtained from the operational experience of Happy Smiles Dental Clinic, serving as a representative study from the dental care sector.

**Results.** According to WHO studies, every year between 2000 and 2019, an estimated 489,000 people died as a result of heat waves. 45% of them are in Asia and 36% in Europe. In Europe, in the summer of 2022, deaths are estimated to be 61,672. The workload of dental practices in Bulgaria during the summer months can increase significantly due to the dental tourism that takes place in the country.

**Conclusions:** The EU predicts a loss of around 0.5-1% of GDP due to reduced productivity and sick leaves related to heat stress, with southern Europe being more affected. It is necessary to adopt prevention measures when working in extremely hot temperatures for dental specialists and patients.

**Keywords:** heat stress, heat waves, extreme temperatures, well-being, dentists,

## INTRODUCTION

Globally, over 1 billion workers are exposed to the risk of heat stress, with particularly high vulnerability in sectors such as agriculture, construction, manufacturing and heavy industry [13, 14]. Heat stress not only impairs worker productivity but also poses serious short- and long-term health risks, including dehydration, heat exhaustion, heat stroke and exacerbation of pre-existing cardiovascular and respiratory conditions. Protecting workers from heat-related hazards is therefore a complex, multi-layered process that requires systematic preventive measures, encompassing both organisational policies and individual behaviour. The effectiveness of these measures is largely influenced by workers' knowledge, awareness and adherence to safety practices, as well as the culture of occupational health within the workplace.

While extensive research has examined heat stress in physically demanding industries, relatively little attention has been given to healthcare settings, including dental practices, where staff are frequently exposed to high ambient temperatures due to equipment use, protective clothing and ventilation limitations. Employers in such environments carry a critical responsibility to implement comprehensive preventive strategies that go beyond simple workplace modifications. These strategies should focus on minimizing heat exposure, ensuring adequate hydration, providing regular breaks and promoting both staff and patient awareness of heat-related risks.

Key indicators for assessing heat stress risk include ambient temperature and humidity, duration of exposure, physical workload, personal protective equipment use and individual susceptibility factors such as age, health status and acclimatization. However, there remain significant gaps in understanding how these indicators interact in healthcare contexts, particularly in small-scale practices where resources for occupational health management may be limited [16, 17]. Furthermore, there is insufficient evidence on the effectiveness of tailored preventive

interventions in dental practices and on the role of employee training and workplace culture in mitigating heat-related health risks.

In the context of extreme temperatures, addressing these gaps is essential to developing evidence-based guidance for dental practice management that ensures well-being, maintains service quality and aligns with broader occupational health standards [1, 15]. This study aims to explore these aspects, highlighting both the known indicators of heat stress and the areas where further research and practical interventions are needed.

## **MATERIALS AND METHODS**

This study is based on a review of relevant scientific literature and regulatory frameworks. The literature was identified through accessible sources using keywords. Data were also drawn from existing occupational health and safety regulations, peer-reviewed publications, and the applied practices of LOT-CONSULT, an established provider of occupational health and safety services. Additionally, insights were obtained from the operational experience of Happy Smiles Dental Clinic, serving as a representative case study from the dental care sector.

## **RESULTS**

### **Employers' key heat-resilient measures for dental healthcare workplaces**

The role of the employer in organising, controlling and planning the activities in accordance with temperature variations is of primary importance and includes:

- Enhancing staff awareness and knowledge by provision of training to dental professionals (dentists, dental assistants, nurses, dental technicians, orderlies, and others) on heat stress, early warning signs, symptoms of heat-related illnesses, the importance of hydration, and appropriate first aid responses in emergencies.

- Adjusting work-rest cycles and schedules by:
  - updating the physiological work-rest regime and shift planning so that heavier tasks are performed during the cooler parts of the day (early morning or late afternoon).

- ensuring frequent and extended breaks in shaded or air-conditioned areas, particularly during peak heat hours.

- introducing shift rotation to minimize individual exposure to extreme heat and reduce the time each worker spends in high-temperature environments.

- Hydration and always ensuring easy access to cold drinking water.

- Clothing and personal protective equipment (PPE) that provide lightweight, loose-fitting, light-colored clothing made from breathable and natural materials.

- Workplace and environmental control performed by maintaining shaded or air-conditioned rest areas; ensuring adequate ventilation to improve air circulation in enclosed spaces; and, where necessary, installing cooling stations or evaporative cooling fans. Usage of indoor thermometers to monitor ambient temperatures regularly.

- Health monitoring via conducting regular preventive medical check-ups to monitor the condition of employees and identify individuals at higher risk of heat-related illnesses.

- Emergency preparedness and development and implementation of emergency response procedures for heat-related incidents, including ensuring rapid access to medical care when needed.

Dental practices are among the types of workplaces where remote work is not feasible during heat waves. For this reason, employers and dental practice managers must regularly monitor the heat index and limit overtime during periods of extreme heat to reduce overall exposure time.

### **The role of occupational safety and health (OSH) professionals in managing these risks**

Employers depend on the expertise and commitment of the OSH professionals to implement a broad range of measures that ensure a safe working environment. Increasingly, it becomes evident that formal compliance with regulatory requirements is a necessary but insufficient condition for achieving real effectiveness in protecting workers' health and safety [2]. According to the European Agency for Safety and Health at Work, around 25-30% of workers in Europe are potentially exposed to extreme temperatures during the summer months, especially in southern Europe [3].

When working in high temperatures, activities include assessing the level of risk for workers and identifying potential heat hazards, identifying vulnerable employees at higher risk due to factors such as health status, age, or levels of acclimatization, developing heat stress prevention programs tailored to the specific needs of the workplace - work and rest schedules, work clothing, PPE, hydration, etc.

Safety and health experts and occupational health services are actively involved in organizing and conducting training for workers and managers on heat-related risks, symptoms of heat stress, preventive measures, and the provision of first aid, and are responsible for promoting awareness through posters, newsletters, and regular communications with workers. In line with the trends towards ensuring well-being in the workplace, health, and safety experts are increasingly involved in health promotion activities, health and wellness programs that improve overall physical fitness and heat resistance.

When working in high-temperature conditions, activities should include assessing the level of risk to workers and identifying potential heat-related hazards, as well as recognizing vulnerable employees who may be at greater risk due to individual or occupational factors.

#### **Control of air-conditioning and ventilation systems**

The role of engineers from inspection and control bodies is also of key importance. They are responsible for evaluating the effectiveness of ventilation, air conditioning, and cooling systems, and for monitoring microclimate parameters during both the hot and cold seasons.

Occupational health physicians and medical specialists from occupational health services are responsible for analyzing the results of preventive medical examinations and temporary morbidity data within enterprises. They monitor workers for signs of heat stress or heat-related illnesses and identify patterns and areas for continuous improvement.

#### **Strategic planning of work with different age groups of patients in dental practices**

Working older adults in the context of extreme heat, as well as elderly patients, are highly vulnerable to the impacts of heat waves. Alarming statistics increasingly show a significant rise in heat-related mortality among older populations, including those still active in the workforce. The causes of this increase go beyond the well-known age-related decline in thermoregulation and the presence of chronic conditions (such as cardiovascular disease, diabetes, etc.) that may be exacerbated by heat exposure.

Additional contributing factors include global climate change, which is driving more frequent and intense heat waves that disproportionately affect vulnerable population groups, as well as the phenomenon of urban heat islands - urban areas that are significantly warmer than rural ones due to human activity and infrastructure that absorbs and retains heat.

Older adults who work outdoors or in physically demanding environments are at greater risk of developing heat-related illnesses. At the same time, many seniors continue to work, often in conditions that may not be fully appropriate for their age or health status.

In dental care, the scheduling of appointments for elderly patients should consider the time of day. It is advisable to book appointments during the cooler morning hours, particularly when the treating dental professional is scheduled for the early shift. Consideration should also be given to the duration and type of dental procedure, as well as the patient's return home. For example, surgical interventions such as the extraction of periodontally

compromised or impacted teeth, placement of dental implants, wisdom tooth extractions, or other oral and maxillofacial procedures should, where possible, be scheduled in the first half of the day. Patients should be informed that it is best not to drive themselves and to return home with a companion.

In high-end dental clinics, services such as transportation to the patient's home (or hotel, in the case of dental tourism) via a dedicated clinic vehicle with a driver are often offered. Such measures significantly enhance patient comfort and reduce the risk of complications or heat stress during the hot summer months, particularly in southern countries such as Bulgaria.

What Can Be Done? - During periods of extreme heat, older workers should be encouraged to take regular breaks and have easy access to drinking water as well as shaded or air-conditioned rest areas. Their working hours should be flexible and adapted to their specific needs and individual characteristics to ensure safety and well-being. [4].

#### **DISCUSSION**

According to Ordinance No. RD-07-3 of 2014 on the minimum requirements for microclimate, workplaces in enclosed work premises must comply with either the optimal or permissible limit values, depending on the type of air conditioning of the premises. The optimal limit values depend on the season of the year and the category of work and apply to air-conditioned production premises and permanent workplaces, while the permissible limit values depend on the season of the year, the category of work, and the type of workplace. They apply in cases where, due to technical and technological reasons, it is not possible to ensure compliance with the optimal limit values.

For "light physical work," i.e., work that does not require systematic physical exertion, the optimal limit values during the warm period for air-conditioned premises are between 22°C and 25°C, while the permissible limit values for permanent workplaces are 18–28°C. The recommended air humidity in the premises should be between 40% and 60%. [5]

The health consequences include heat stress, dehydration leading to reduced cognitive function and physical performance, respiratory problems, and others. [6] High ambient temperatures have a negative effect on patients with inflammatory conditions and infections in the maxillofacial area and slow down the healing process. Moreover, reduced body hydration as a result of heat stress decreases saliva production, which can increase the risk of caries and periodontal diseases such as gingivitis.

The consequences on productivity include limited cognitive performance (impaired concentration, memory, and decision-making), reduced endurance, increased fatigue, leading to lower productivity and higher error rates, more frequent absenteeism, and workplace accidents. [7]

High temperatures reduce attention span and concentration levels, which directly affect workers' ability to make quick and accurate decisions. Reaction time becomes slower, leading to an increased number of errors. Heat raises the body's energy expenditure, causing fatigue to set in more quickly. This is particularly important in physically demanding jobs. Fine motor skills and coordination also deteriorate under high temperatures. Frequently, elevated temperatures cause discomfort and irritability, reducing employees' motivation and engagement.

According to the World Health Organization (WHO), productivity can decrease by about 2% per degree Celsius when the temperature rises above 25°C [8]. The Lawrence Berkeley National Laboratory in the USA similarly reports that office workers' productivity drops by approximately 2% for each 1°C increase above 25°C.

At temperatures above 30°C, productivity losses can range from 5% to 20%, depending on the type of work and level of physical activity. The International Labour Organization (ILO) notes that under extreme heat conditions (above 35°C), productivity losses can exceed 50% for outdoor tasks and manual labour.

According to the ILO, in the coming decades up to 2050, without appropriate measures, more than 4% of global working hours will be lost, with Europe and other developed regions also being affected [9]. This statistic highlights the need for adaptation measures and stricter regulations, especially in countries with rising summer temperatures, to ensure workers' health and safety.

The rules for preventing risks during extreme heat are:

- Hydration: ensuring easy access to drinking water and regularly encouraging workers to drink water even if they are not thirsty. Water coolers or bottles of water should also be freely available to patients in the reception area.

- Work schedule adjustments: planning heavy work tasks for the cooler parts of the day, such as early morning or late afternoon; frequent and regular breaks in shaded or air-conditioned areas; encouraging the use of breathable, loose clothing [10].

- Heat index monitoring: regularly monitoring the heat index (temperature and humidity) to assess risk levels.

- Emergency procedures: introducing procedures for recognizing and responding to heat-related illnesses,

including first aid and emergency medical assistance.

- Heat stress training: training workers on the risks of heat exposure, the symptoms of heat-related illnesses, and preventive measures.

- Manager training: training managers to recognize early signs of heat stress and take appropriate action.

- Engineering controls: providing shaded rest areas; using suitable cooling equipment (fans, misting systems, or portable air conditioners).

Administrative controls:

- Acclimatization: gradually increasing heat exposure for new workers or those returning after an absence to allow adaptation.

- Job rotation among workers in dental practices or dental laboratories to reduce the duration of heat exposure for everyone.

- For patients: traveling to and from the dental clinic in air-conditioned vehicles, wearing wide-brimmed hats and loose, light, breathable clothing, and scheduling visits during the cooler hours of the day, preferably in the early morning.

General prevention tips for all heat-related conditions:

- Hydration: Maintaining body hydration by drinking plenty of fluids throughout the day.

- Appropriate clothing: wearing light-coloured, loose-fitting clothes made from natural fabrics.

- Regular breaks in cooler areas.

- Use of sun protection: sunscreen, sunglasses, and wide-brimmed hats for patients.

- Monitor the weather conditions and pay close attention to heat warnings and advisories.

- Gradual acclimatization: allowing the body to adapt to hot conditions over several days.

- Training for workers and supervisors on recognizing and responding to heat-related illnesses.

In case of symptoms, a quick and appropriate action can prevent serious health consequences.

Chronic diseases that increase the risk from high temperatures for medical staff and patients include:

- Cardiovascular diseases: conditions such as heart disease, hypertension, and stroke worsen with heat, increasing the strain on the heart and leading to complications.

- Respiratory diseases: chronic obstructive pulmonary disease (COPD), asthma, and other respiratory conditions.

- Diabetes: heat affects blood sugar levels and raises the risk of dehydration. People with diabetes also sweat less, which makes cooling more difficult.

• Kidney diseases: chronic kidney disease (CKD) and other renal problems worsen with dehydration, which is more likely in high temperatures.

• Neurological disorders, e.g., multiple sclerosis.

• Obesity: excess body fat reduces the body's ability to regulate temperature and increases the risk of heat-related illness.

• Mental health disorders: conditions such as depression and schizophrenia can impair perception of temperature and the ability to take proper cooling measures.

To minimize risks for people with chronic illnesses, the following measures are recommended:

• Hydration: drinking plenty of fluids (water and electrolyte solutions) and avoiding alcohol and caffeine.

• Regular monitoring of vital signs such as blood pressure and blood sugar.

• Working in air-conditioned rooms as much as possible during heat waves.

• Usage of fans and cooling devices, and ensuring good ventilation indoors.

• Appropriate clothing: light, loose, and light-coloured clothes made from natural fabrics.

• Scheduling outdoor activities for the cooler parts of the day, such as early morning or late evening.

• Frequent breaks in the shade or cool places.

• Sun protection: Usage of a broad-spectrum sunscreen with an SPF of at least 30.

• Awareness and training on the symptoms of heat-related illnesses.

• Healthy diet: eating light meals, avoiding heavy, hot foods that may raise body temperature; include fruits and vegetables with high water content.

In the context of our case study at Happy Smiles Dental Clinic, the practical application of these preventive measures highlights both the opportunities and the challenges of implementing heat risk management in a small healthcare setting. Observations during peak summer months revealed that staff compliance with hydration protocols and scheduled breaks significantly improved comfort and concentration levels, while the use of portable air conditioners and fans helped maintain the microclimate within permissible limits. Nevertheless, limitations in infrastructure, such as restricted space for shaded rest areas and variability in ventilation across treatment rooms, underscore the need for tailored strategies adapted to the

clinic's specific layout and workload. Moreover, patient flow and the necessity to maintain uninterrupted dental care require balancing heat mitigation measures with service efficiency.

Our perspective emphasizes that while regulatory guidelines provide a framework for a safe working environment, the effectiveness of heat stress management in dental practices relies heavily on proactive monitoring, staff training and the customization of administrative and engineering controls to the unique characteristics of each clinic. This approach not only protects staff but also contributes to sustained quality of patient care and overall operational productivity.

## CONCLUSION

Working in extreme temperatures poses a serious challenge to the safety and health of dental practitioners and their patients. Global warming is increasing the frequency and intensity of heat waves, which poses an increasing risk to people working outdoors or in hot environments, such as dental laboratories and dental practices. The most serious health risks associated with working in hot temperatures are heat stroke, exhaustion, heat cramps, and cardiovascular and respiratory complications. The number of workers at risk from extreme temperatures is expected to increase as climate change accelerates. In the long term, investment in air conditioning systems and adaptive technologies to reduce temperatures in industrial areas is needed [11].

Recommended safety measures for dentists, nurses, dental assistants, dental technicians, orderlies, and others include staff rotation, worker hydration, and training in recognizing the symptoms of heat stress. These require careful planning and implementation of strategies to protect workers in extreme conditions [12].

Recommended safety measures for at-risk patients, including the elderly, pregnant individuals, and those with chronic illnesses, comprise scheduling appointments during the cooler hours of the day, providing escort assistance to and from their homes, ensuring free access to drinking water in the reception area, maintaining effective air conditioning and ventilation in waiting rooms, regularly monitoring indoor temperature and humidity levels, offering blood pressure measurement when needed, and, if appropriate, reducing the duration of dental procedures.

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