Heat Stress In The Workplace

THE ESSENTIAL GUIDE

Managing Heat Stress in the Workplace

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HEAT STRESS IN THE WORKPLACE

Heat stress is a serious issue in the Australian workplace and can have serious health and safety implications from headache to potentially, death.

During the summer months nearly all Australian workers will face dangerously hot conditions, while many others must deal year-round with the sun and its associated perils.

Research has found that workplace accidents are highest in the summer months[1,2] when injury rates increase along with hotter ambient temperatures.[3]

Many workplaces have implemented measures to monitor potential heat stress threats using tools such as the Wet Bulb Globe Temperature (WBGT) and Thermal Work Limit (TWL) indices in an attempt to protect workers; however, such tools have limitations and must be used in conjunction with other protection measures.

Those measures should include monitoring workers to guide the implementation of strategies to maintain their health, safety and performance.

Managing worksite heat stress is also likely to lead to increased productivity through fewer accidents, injuries and less downtime.[4]

WORKING IN THE HEAT

Working in cool conditions allows the body to easily transfer heat to the environment; however, working in hot or humid conditions limits that transfer. The result is an increased core body temperature, especially when performing physical tasks and wearing protective clothing or equipment such as goggles, earmuffs, boots and gloves.

The body has two key methods to limit heat storage: sweating and increasing blood flow to the skin. If the body temperature continues to rise, concentration is affected to the point that focusing becomes difficult, endangering not only the health of the workers but the safety of their co-workers.

HEAT RELATED ILLNESSES

Heat-related illnesses and associated symptoms vary depending on the level of heat exposure.

Heat Exhaustion

Is the inability to continue working in the heat and is associated with the symptoms in Table 1. Workers may have an elevated core body temperature but not necessarily feel hotter than their co-workers. With appropriate care a full recovery is likely.

Heat Stroke

Is diagnosed by a high core body temperature (>41°C) and mental impairment. It is a medical emergency requiring immediate treatment. Consequences (found in Table 1) can be severe and depend on the duration and extent of core body temperature elevation. Permanent loss of function or death is possible[5] as is permanent organ damage due to the body's internal systems shutting down.

Tabel 1: Heat Stress Symptoms[6]

Heat Exhaustion	Heat Stroke
Normal – elevated core body temperature	High core body temperature (>41°C)
Dehydration	Emotional instability
Profuse Sweating	Drowsiness
Light headedness	Seizures
Nausea	Disorientation
Fainting	Irritability
Fatigue	Dizziness
Headache	Impaired judgement
Pale skin	Lack of coordination
Hyperventilation	Aggression
Urge to defecate	Elevated heart rate
Chills	Vomiting

HEAT HANGOVER

Not all heat-related illnesses occur during work hours, with a post-shift headache and nausea common symptoms of what is described by Northern Territory based heat stress expert, Dr. Matt Brearley, as a 'heat hangover' due to similar symptoms to an alcohol hangover. Brearley believes that the heat hangover has become increasingly prevalent on Australian worksites over the past five years.

He states that the heat hangover is likely to compromise safety as staff operate at a fraction of their physical and mental capacity.

There is also anecdotal evidence of reduced social interaction and tolerance of others as a result of the heat hangover, contributing to what is known as 'mango madness' in the tropics.

Milder consequences are likely to include lower productivity, as the impact of physical work and body heat storage causes employees to pace their efforts during subsequent work shifts.

CASE STUDY

The National Critical Care and Trauma Response Centre researched how the heat hangover develops by examining emergency responders during a 24-hour exercise conducted in very hot conditions.[7]

Responders commenced work at 1p.m., completing 15-hour shifts over a 24 hour period. Between nine and 21 hours into the exercise, seven of the 16 staff reported to the onsite medical team with symptoms of nausea[7], headache[7] and vomiting[1]. Interestingly, neither the core body temperature or heart rate observations, nor measurements from the two hours' prior were synonymous with heat-related illness.

It appears substantial body heat storage, heart rate and sweat rates during the initial four hours of the response, followed by moderate body heat storage during subsequent shifts, promoted the heat hangover symptoms.

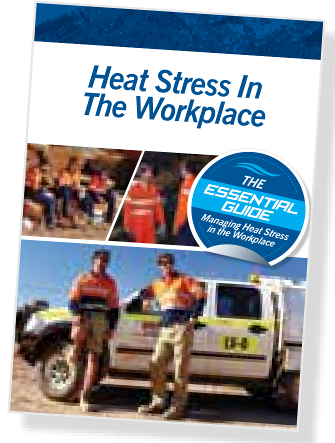
EDUCATION AND TRAINING

Educating workers to recognise the signs and symptoms of heat-related illness - both in themselves and their co-workers - as well as understanding predisposed risk factors (see Table 2) is an important step to minimising harm.

Self-diagnosis and self-pacing (discussed p5-6) should be encouraged; however, due to the nature of symptoms and fear of co-worker perceptions of weakness; it should not be relied upon.

A heat stress management policy should be implemented, outlining specific responsibilities of personnel, team leaders, planners, schedulers and senior management to prevent, identify, manage and control heat stress.

The policy should outline training for staff to reduce the occurrence of heat stress as well as identify potential hazards, signs and symptoms in co-workers and procedures for management. Factors that influence heat tolerance should also be outlined: physical fitness and nutrition are positive contributors whereas obesity, some medications and sleep deprivation reduce tolerance.



Controls available for the prevention and management of heat stress should be detailed and include heat acclimatisation, dehydration prevention and cooling strategies (see Heat Stress Mitigation Strategies below).

Table 2: Risk Factors For Development Of Heat Related Illness

- History of heat illness
- Non heat acclimatised
- Low fitness
- Obese / Overweight
- Feeling unwell
- Lack of heat education
- Limited history of working in the heat
- Dehydration
- Certain medications
- Limited access to cooling
- Limited access to fluids
- High levels of PPE
- Highly motivated
- Lack of scheduled breaks
- Short staffed

WHO IS AT RISK?

The industries and workers most at risk of heat stress are those dealing with high ambient temperatures and humidity, working in poorly ventilated areas, use heat producing tools and machinery, in close proximity to heat storing materials such as rock, metal and concrete and require substantial protective clothing and equipment.

Such industries include construction, oil and gas, defence, mining, utilities, manufacturing, agriculture, law enforcement and emergency response.

Also at risk are workers who have an unhealthy lifestyle including low levels of exercise, poor diet, a lack of sleep and being overweight – all of which contribute to lower heat tolerance.[8]

Those poor lifestyle choices also correlate with dehydration, with obese or overweight workers significantly more likely to be dehydrated at work than those of a healthy weight.[9]

MONITORING THE ENVIRONMENT

Given the environment's role in the ability of the body to dissipate heat, monitoring environmental conditions may assist in identifying higher risk periods for worksite heat stress.

The most common weather condition and associated heat stress monitoring indices are the Wet Bulb Globe Temperature (WBGT) index and the Thermal Work Limit (TWL).

- **WBGT**

  The WBGT is incorporated into ISO 724310 and uses a dry bulb to measure air temperature along with a thermometer encased in a wet cotton sleeve (wet bulb) and a thermometer in a black globe that accounts for radiant heat - the combination producing the WBGT 'temperature'.

  In determining work-to-rest ratios, variable inputs such as the amount of clothing and PPE worn by workers as well as their work load need to be applied – both potential sources of error. Underestimating the stress of a high temperature, high humidity and low air flow environment is an additional weakness of the WBGT[11].

- **TWL**

  TWL is calculated from the environmental measures used to calculate WBGT, with the addition of wind speed and atmospheric pressure to produce a theoretically safe maximum metabolic rate for workers to limit the rise of core body temperature.

  Recommendations are provided for fluid intake, suitability for non-heat acclimatised workers and work-to-rest ratios. While working in the TWL 'buffer' zone, heat stress reduction measures are recommended; however, there are no inputs to guide how these measures might affect work-to-rest ratios or non-heat acclimatised workers.

It is unrealistic to rely on any single measure and environmental monitoring should be combined with the monitoring of workers to determine the effect of heat stress prevention and management strategies.

HEAT ACCLIMATISATION

The human body has the capacity to adapt to regular heat exposure with physical activity. Benefits of acclimatisation include a lower perception of effort, decreased heart rate, lower core body temperature at rest and during physical activity[12] as well as increased sweat production.[13]

ACCLIMATION CASE STUDY

Recent research has shown that after work by emergency responders in tropical conditions the core body temperature of non-heat acclimatised workers plateaued at 38.1°C while heat acclimatised workers reached 38.5°C despite both groups having the same starting temperatures and similar workloads.[7]

The non-heat acclimatised workers felt hotter at a lower core body temperature, likely causing them to limit work rate and body heat production to prevent heat related illness – leading to lower productivity.

This research complements athlete data showing work-rate is selected according to body temperature irrespective of environmental conditions.[14]

Allowing workers to self-pace in the heat is an appropriate strategy, particularly for non-heat acclimatised workers. This is an important consideration for Fly In Fly Out (FIFO) crew during the initial days of a work swing when they may not be as productive as their counterparts.

Workers returning from 14 days or more off in cooler environments should perform modified duties for the initial two to four days upon returning to work in hot conditions to allow for re-acclimatisation. Physical training during days off will assist.

To effectively pace their effort in the heat, workers require an understanding of their work schedule and timeframe for completion, number of staff available, equipment available and the anticipated environmental conditions. Workers should also factor in their personal experience, physical fitness and well-being on the day.[15,16]

Self-Pacing For Non-Acclimatised Workers:

- Understand work schedule and number of staff available
- Equipment available
- Anticipated environmental conditions
- Individual fitness, experience and well-being

COOL AS ICE

Research into cooling strategies to limit body heat has generally focused on treating heat stress rather than preventing it.

However, crushed ice ingestion (commonly known as slushies) is effectively being used as a prevention strategy on mines and construction sites in the tropics of Northern Australia thanks to its ability to substantially lower core body temperature by acting as heat sink in the body.

Initially trialled in 2003 with athletes[17] and studied prior to the 2008 Beijing Olympics,[18,19] the ingestion of ice was shown to be a superior method of lowering core body temperature than fluids served at 4°C. In addition to the cooling benefits, crushed ice ingestion also improved endurance performance in the heat.

The cooling benefits observed for elite athletes have been replicated in occupational settings. Firefighters wearing protective clothing while working in an extremely hot fire cell were able to lower their core body temperature more effectively when they consumed crushed ice during a rest break than the standard practice of resting in the shade with a cold drink.[20]

These findings have implications for use of ice ingestion in hot workplaces as workers who feel cooler are likely to select a higher pace, probably leading to increased productivity.[21]

HEAT STRESS MITIGATION STRATEGIES:

The following information provides actionable steps and guidelines that HSE or OHS officers, safety professionals, managers and business owners can follow to practically mitigate heat stress for those working in hot Australian conditions.

1 EDUCATION

Training workers to recognise the signs and symptoms that a heat affected co-worker will exhibit and teaching procedures to manage that heat stress is essential.

Topics should include lifestyle factors that contribute to heat tolerance such as the prevention of obesity, maintaining physical fitness and heat acclimatisation.

Formal training sessions can assist in achieving education goals while on site discussions are also recommended. Heat awareness education should be scheduled for the transition to hotter weather and may be repeated during hot spells.

2 MONITORING OF WORKERS:

Workers that perform physically demanding jobs in the heat can be considered industrial athletes. To assist these ‘athletes’ recover from each shift and manage their ongoing workload, monitoring may be beneficial.

Analysis of the skin and core body temperatures in response to working in the heat is the most appropriate method of determining risks of heat related illness.

When combined with hydration monitoring through the analysis of urine samples and evaluation of body mass change from pre to post shift, a thorough understanding of workers can be developed, enabling more effective heat stress prevention and management strategies as well as awareness education

3 WORK RATE:

The harder you work the more body heat you produce. Work rates need to match individual workers who should be allowed to self-pace and adjust their workload based upon how they are feeling.

Scheduling of work in hot conditions needs to reflect the environmental conditions, ensuring work rates are not leading to decreased worker safety and heat illness.

4 HEAT ACCLIMATISATION AND FITNESS:

With exposure and time the human body has the capacity to improve tolerance of hot and humid conditions.

Regular physical activity that results in high sweat rates can improve heat tolerance and make the transition to a hot workplace less stressful. Physical fitness is the single best predictor of tolerance to the heat.[8]

5 ICE INGESTION:

Crushed ice ingestion acts as a heat sink in the body and is a proven method to effectively lower core body temperatures, providing improved performance in the heat and likely leading to increased worker productivity.

6 COOLING:

The benefits of crushed ice ingestion highlight the role cooling can play in mitigating heat stress. There are a number of worker cooling strategies that can be implemented. Cooling method availability will vary between worksites and it is recommended to consider what strategies are practical and acceptable.

6.1 PPE-Free Areas:
Establishing areas on site or close to site where workers are able to remove PPE and clothing to enable them to cool their core body temperature more quickly is an important element in minimising heat stress in the workplace.

Having cooling fans and air conditioning in these PPE-free areas will further serve to help minimise heat-related illness.

6.2 Cooling Fans:
Using cooling fans throughout the workplace and in PPE-free areas will facilitate air flow and encourage sweat evaporation or “evaporative cooling” – the primary purpose of sweating.

Sweat evaporation lowers the body temperature, prevents additional heat storage and may actually reduce further sweating.

6.3 Cooling Vests:
There is some research that suggests wearing ice vests or other cooling vests may assist in minimising heat stress; however, there is insufficient data to provide conclusive evidence.

While they can play a role in a greater heat stress management program, their application should be site and task specific.

7 HYDRATION:

With studies finding that up to 60%[22,9] of mining workers begin their shift dehydrated, monitoring and maintaining worker hydration levels using Urine Specific Gravity (USG) testing (measuring water balance and urine concentration) is an important tool for enhancing worker productivity, safety and education.

Even mild dehydration (classified as a loss of fluids between 1-4% of body mass) negatively impacts decision-making, cognitive performance, attention and visual motor tracking, potentially leading to reduced productivity and an increased risk of work-related accidents.[23]

In fact, 3% dehydration is the equivalent of having a Blood Alcohol Content (BAC) of 0.08 which has been found to slow down the response time of drivers by 17%[23] and increase the chances of having a car accident by five times.[24]

For those arriving at work already dehydrated, research has found they are 2.6 times more likely to also end their shift dehydrated,[9] endangering themselves and their co-workers throughout their shift.

Pre and post-shift hydration testing of the urine for specific gravity - the method used in the above mentioned studies - will help establish whether workers are hydrated at the start of their shift and consuming enough fluids during it. Results for both tests should be recorded and tracked for future reference as should workers' individual fluid consumption levels.

More information can be found in this USG Program Implementation Guide while further strategies for preventing dehydration can be found in in our complimenting information Booklet - "Workplace Dehydration - Minimisation and Management".

8 NUTRITION:

Food can be a great source of energy and electrolytes during the work shift; however, loss of appetite is common in the heat which may limit consumption.

It is important to prevent extended periods without food, with six to eight hours considered the limit when high sweat rates are encountered.

9 SLEEP:

Uninterrupted sleep is a major component of post-shift recovery. While the amount of sleep required varies from person to person, the American National Sleep Foundation recommends 18-64 year-olds sleep between seven and nine hours each day.[25]

Sleep should be in a cool environment to allow for body heat loss and enable a low core body temperature at the commencement of the next work shift. Sleeping in warm or hot conditions contributes to heat related illness.[26]

10 MONITOR THE ENVIRONMENT:

Monitoring environmental conditions can assist in identifying high risk periods for worksite heat stress.

There are a range of indices to assess heat stress risk based upon climatic conditions; however, it is unrealistic to expect a single measure to mitigate workplace heat stress and any environmental monitoring should be part of an over-arching heat stress management strategy.

11 HEAT STRESS MANAGEMENT POLICY

A policy detailing the responsibilities of personnel, team leaders, planners, schedulers and senior management in preventing and managing heat stress in staff is an essential document for organisations that operate in hot conditions.

Policies must be understood at all levels of the organisation and created from relevant research, worker monitoring data, worker experiences, advice from peers and legislative requirements.[7]

Reducing workplace heat stress by implementing management strategies including worker and environmental monitoring is likely to limit the prevalence of the heat hangover and minimise the physiological, psychological and social impacts of working in the heat.

Managing workplace heat stress is also likely to result in fewer accidents and increased productivity.[5]

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