ADVISORY : HEAT RELATED ILLNESSES

Qualitatively, heat wave is a condition when high temperature of the air becomes fatal to the human body.

Population exposure to heat is increasing due to climate change. Globally, extreme temperature events are increasing in their frequency, duration and magnitude.

While the effects of heat may be exacerbated in cities, due to the urban heat island (UHI) effect, the livelihoods and wellbeing of non-urban communities can also be severely disrupted during and after periods of unusually hot weather.

Heatwaves can burden health and emergency services and also increase strain on water, energy and transportation resulting in power shortages or even blackouts/outages. Food and livelihood security may also be strained if people lose their crops or livestock due to extreme heat.

Global temperatures and the frequency & intensity of heatwaves rise as a result of climate change. Extended periods of high day and night time temperatures create cumulative physiological stress on the human body which exacerbates the major causes of death globally, including respiratory and cardiovascular diseases, Diabetes Mellitus and renal disease. Heatwaves can acutely impact large populations for short periods of time, often trigger public health emergencies, and result in excess mortality, and cascading socioeconomic impacts (e.g. lost work capacity and labor productivity). They can also cause loss of health service delivery capacity, where power-shortages disrupt health facilities, transport and water infrastructure.

In our Country, Heat waves typically occur from March to June. On an average, five-six heat wave events occur every year over the Northern parts of the country.

Criteria for declaring heat wave in India :

Heat wave is considered if maximum temperature of a station reaches ≥ 40°C or more for Plains and ≥ 30°C or more for Hilly regions.

Based on Deviation/Departure from Normal Heat Wave:

If deviation from normal is 4.5°C to 6.4°C, it is normal Heat Wave.

If deviation from normal is >6.4°C, it is severe Heat Wave.

If above criteria is met at least in 2 stations in a Meteorological sub-division for at least 2 consecutive days.

Health Impact of Heat :

- Normal human body temperature ranges between 36.4°C to 37.2°C (97.5° F to 98.9°F).
- Exposure to high outdoor and/indoor temperatures can induce heat stress, directly and indirectly, leading to heat related illnesses.
- Heat stress may also exacerbate chronic diseases like cardiovascular, respiratory and kidney diseases.

Spectrum of illness due to Heat (from mild to severe) : Cascade of illnesses : Skin eruptions, **heat rash** (prickly heat), **heat oedema** (swelling of hands, feet and ankles), **heat fatigue**, **Heat hyperpyrexia, heat exhaustion, heat syncope** (fainting)**, heat cramps** (muscle cramps), **heat tetany, heat stroke, burns**.

When generation of heat exceeds the body's capacity for heat loss, core temperature rises. Exertional Heat Illness (EHI), on the other hand, typically develops in athletes when heat production exceeds the body's ability to dissipate it. Non-Exertional Heat Illness (NEHI) occurs when there is high environmental temperature in those with attenuation thermoregulatory control mechanisms : elderly, young, those with co-morbidity or those taking drugs that affect thermoregulatory control mechanism (particularly Phenothiazines, Diuretics and Alcohol).

Acclimatization mechanisms to environmental heat for maintaining body sodium balance include stimulation of the sweat mechanism with increased sweat volume, reduced sweat sodium content. The risk of heat-related illness fall as acclimatization occurs.

Prevention : Adequate replacement of salt and water, although excessive water intake alone should be avoided because of the risk of dilutional Hyponatraemia.

Heat Cramps :
These painful muscle contractions occur following vigorous exercise and profuse sweating in hot weather. There is no elevation of core temperature.

Mechanism : Extracellular Sodium depletion occurs as a result of persistent sweating, exacerbated by replacement of water but not salt. Symptoms usually respond rapidly to rehydration with oral rehydration salts or intravenous saline.

Differential diagnosis in patients with elevated core body temperature :

Heat illness (heat exhaustion, heat stroke)	Drug overdose
Sepsis, including meningitis	Malignant hyperpyrexia
Malaria	Thyroid storm

Heat Syncope :
This is similar to **Vasovagal Syncope**/faint and is related to peripheral vasodilatation in hot weather.

Heat exhaustion :
Heat exhaustion occurs with prolonged exertion in hot and humid weather, profuse sweating and inadequate salt and water replacement. There is an elevation of 37^{o}C to 40^{o}C in core (rectal) temperature.

Investigations : Blood analysis may show evidence of dehydration with mild elevation of the Blood Urea, Sodium and Haematocrit.

Treatment : Remove the patient from the heat, and ensure active evaporative cooling using tepid sponging/sprays and fanning (strip-spray-fan). Fluid losses are replaced with either oral rehydration mixtures or intravenous isotonic saline. Untreated, heat exhaustion may progress to heat stroke.

Heat Stroke : It occurs when the core body temperature rises above 40^{o}C and is a life-threatening condition.

Symptoms : already existing symptoms of heat exertion progress to headache, nausea & vomiting. Neurological manifestations include a coarse muscle tremor and confusion, aggression or loss of consciousness, skin feels very hot and sweating is often absent due to failure of thermoregulatory mechanisms.

Complications : Hypovolaemic shock, Lactic Acidosis, Dissemination Intravascular Coagulation (DIC), Rhabdomyolysis, Hepatic and Renal Failure, Pulmonary and Cerebral Oedema.

Treatment : Resuscitate with rapid cooling by spraying with water, fanning and ice packs in the axillae and groins. Cold crystalloid intravenous fluids are given but solutions containing potassium should be avoided. Overaggressive fluid replacement must be avoided, as it may precipitate pulmonary oedema or further metabolic disturbance. Monitoring of fluid balance, including Central Venous Pressure (CVP) is important.

Investigations for complications :
Routine Haematology and Biochemistry, Coagulation Screen, Hepatic Transaminases [Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT)], Creatine Kinase and Chest X-Ray PA View. Once emergency treatment is established, heat stroke patients are best managed in intensive care unit.

With appropriate treatment, recovery from heat stroke can be rapid (within 1-2 hours) but patients who have had core temperatures higher than 40^{o}C should be monitored carefully for later onset of Rhabdomyolysis, renal damage. Strict advice to avoid heat and heavy exercise during recovery is important.

Heat Waves and Health :

The scale and nature of the health impacts of heat depend on the timing, intensity and duration of a temperature event, the level of acclimatization, and the adaptability of the local population to the prevailing climate. The precise threshold at which temperature represents a hazardous condition varies by region, other factors such as humidity and wind, local levels of human acclimatization and preparedness for heat conditions. The negative health impacts of heat are predictable and largely preventable with specific public health actions. Exposure to excessive heat has wide ranging physiological impacts for all humans, often amplifying existing conditions and resulting in premature death and disability.

Some key health impacts of heat are:

Deaths and hospitalizations from heat can occur extremely rapidly (on the same day), or have a lagged effect (several days later) and result in accelerating death or illness among the already frail, particularly observed in the first days of heat-waves. Even small differences from seasonal average temperatures are associated with increased illness and death. Temperature extremes can also worsen chronic conditions, including Cardiovascular, Respiratory, Cerebrovascular Disease and Diabetes-Related Conditions.

Heat conditions can affect human behavior, the transmission of diseases, health service delivery, air quality, and critical social infrastructure such as energy, transport, and water.

Physiological aspects of temperature regulation :

Mechanisms of heat exchange :

The body temperature regulation centres in the brain **(Hypothalamus)** attempt to keep the body core temperature within healthy limits. At rest, this is about 37°C, but with exercise the temperature can increase to 38–39°C without any detrimental effect on health, as long as the thermoregulatory system is within its control range. Staying within the control range requires the body to balance heat production by the body and possible other heat gains (e.g. solar radiation) with heat loss. Heat is produced as a result of the metabolic activity required to perform activities. Most of the energy the body uses is released as heat. The body can lose this heat by convection (warming of air or water around the body), by conduction (contact with solids, such as the floor), respiration (air inhaled is usually cooler and dryer than exhaled air) radiation and evaporation of sweat .When air temperature and water vapour pressure increase, the gradients between skin and environment required for these heat losses decrease and heat loss is reduced. When air temperature approaches skin temperature, heat loss by convection approaches zero, and heat may even be gained when air temperature rises above skin temperature. In these cases the main avenue left for losing heat is by producing sweat and evaporation, and even this is compromised with increasing vapour pressure. Heat production then exceeds losses and the body temperature increases. Several effector mechanisms inside the body are involved in regulating body temperature. The most important ones for heat are sweat production to lose heat from the skin and skin blood flow to transport heat from the body core and the muscles to the skin. During heat stress, the proper functioning of both systems is essential for thermal regulation. If they are unduly stressed and cannot match the thermoregulatory demands, this leads to excessive strain on the body and eventually may cause heat illness. Additional effector mechanisms are an increase in some hormones [Antidiuretic Hormone (ADH) and Aldosterone], in respiratory rate and in heart rate. For body temperature to remain stable (heat storage = 0), heat loss needs to balance heat production.

Heat-related illnesses :

Most heat-related illnesses (except for skin eruptions and heat cramps) are in essence consequences of varying severity of failure of the thermoregulatory control mechanism/system. The least severe form is heat syncope, caused by a failure of the circulation to maintain blood pressure and supply oxygen to the brain. As soon as the patient is horizontal, the system recovers quickly. The decline in blood pressure is related to a reduction in venous return, caused by the expansion of the circulatory volume by dilation of skin arteries and veins, often combined with lowered plasma volume because of dehydration. This is exacerbated when no muscle pump (activity) is present to support the venous return of blood to the heart (e.g. a soldier standing still in a parade). When the muscle pump is active (e.g. during exercise), blood pressure can be kept up longer and body heating may progress further, together with high cardiovascular stress, leading to heat exhaustion. If the high heat load from exercise and/or climate in such cases is not removed, this may progress into heat stroke, in which extreme body temperature (above 40.5°C) leads to damage to cellular structures and the thermoregulatory system with a high

risk of mortality. This typically is diagnosed in fit young adults who continue exercising despite feeling unwell, such as during competitions. Heat stroke has a high case–fatality ratio and a rapid onset.

Complications of heat stroke : may include Adult Respiratory Distress Syndrome (ARDS), kidney failure, liver failure and Disseminated Intravascular Coagulation (DIC). Severe functional impairment was observed in 1/3rd of patients admitted with heat stroke during the Chicago heat-wave, with no improvement after 1 year in those still alive. For less fit subjects e.g. elderly people, heat-related illnesses can occur at low levels of exercise or even in the absence of exercises. Low fitness levels lead to a low cardiovascular reserve and thus to low heat tolerance. In addition, several other predisposing factors can accelerate the development of high body temperatures. Similar to fitness, these mostly affect the sweating system (reduced cooling), skin vasodilation (reduced heat movement from core to skin) or cardiovascular reactivity (problems with supply to vital organs and with blood pressure). However, even when exposure is less severe, these processes in reaction to heat can also affect health through other pathways. The increased cardiovascular load in heat (vasodilation and dehydration) exacerbates other health problems such as cardio-vascular disease. Coronary and cerebral thrombosis are due to the loss of water and salt in warm environments leading to haemoconcentration and a thrombogenic increase in viscosity and the density of platelets and Red Blood Cells (RBC). Increased sweat production in heat can lead to dehydration. A fit, acclimatized person can produce up to 3 litres of sweat per hour; a normal person produces up to 1 litre of sweat per hour.

Predisposing factors for heat-related illnesses :

• Age; • lack of acclimatization; • dehydration because of reduced food and fluid intake, intestinal problems, use of diuretics and alcohol abuse; • use of other drugs affecting the temperature regulation system, e.g. Phenotiazines and Barbiturates. • low fitness; • overweight; and • fatigue, sleep deprivation, long-term high-level exercise and protective clothing.

Responses in elderly people :

Older people are more vulnerable to heat because of intrinsic changes in the regulatory system and/or because of the presence of drugs that interfere with normal homeostasis. As homeostasis is impaired, elderly people may not be aware that they are becoming ill from high temperatures and therefore, may not take action to reduce their exposure. Elderly people in institutions, such as residential care homes, are vulnerable to heat-related illness and death. Chronological age, however, independently affects cardiovascular effect or response. Low fitness makes elderly people susceptible to heat-related morbidity and mortality. Since elderly people have reduced sweating capacity, it is essential that the sweat they produce evaporates. This does not happen if ambient water vapour pressure is high. This fact stresses the importance of examining not only air temperature in analysing heat-related morbidity and mortality but also water vapour pressure, or an atmospheric moisture equivalent.

Physiological acclimatization :

Short-term heat acclimatization usually takes 3–12 days but complete (long-term) acclimatization to an unfamiliar thermal environment may take several years. Mechanisms of acclimatization : improve the thermal comfort and exercise performance. As long as sweating is continuous, people can withstand remarkably high temperatures, provided that water and sodium chloride, the most important physiological constituents of sweat, are replaced. Short-term heat acclimatization leads to sweat appearing at the skin surface, at a lower body temperature. It increases the maximal sweat volume and lowers the salt concentration.

Dehydration :

Sufficient fluid intake during heat-waves is essential. Dehydration seems to be a critical factor in contributing to heat mortality, in particular in the frail and older populations. Patients in long-term care who were assessed as confused using the Cognitive Assessment Scale, had significantly lower intake of fluid over 24 hours than lucid patients. The presence of multiple diseases and/or treatment puts elderly nursing home residents at risk for dehydration. Alcohol depresses the Central Nervous System (CNS) and through increased diuresis can further aggravate dehydration. Age, mobility and functional ability, gender, visual impairment, speaking ability, incontinence and the frequency of ingestion sessions were associated with higher risk of dehydration. Incontinence was not found to be a statistically significant risk factor for dehydration. However, it was a risk factor for significantly lower fluid intake compared with continent subjects. In fact, the insidious state of chronic underhydration becomes a physiological balancing act in which frail elderly people become increasingly susceptible to minor environmental or physiological stressors that can precipitate dehydration. The ramifications

of chronic underhydration are further obscured by the fact that, once an elderly individual is hospitalized and treated for an acute health crisis such as pneumonia, the antecedent condition of underhydration is often overlooked. Strategies for providing adequate fluids included standardized 180 ml of fluid intake with each medication administration, fluid rounds in morning and evening and "happy hours" or "tea time" twice a week in the late afternoon. The recommended daily intake of fluids should not be less than 1600 ml per 24 hours to ensure adequate hydration. When heat stress levels are low, there is a small chance of hyperhydration (over drinking), leading to hyponatremia. This typically occurs in young, fit persons participating in sporting events of long duration.

Fitness :

Age and illness are strong predictors, as age highly correlates with increasing illness, disability, drug use and reduced fitness. The higher the maximal oxygen uptake (indicating aerobic fitness) of an individual and/or the larger the individual, the lower the heat strain observed in a warm humid climate (air temperature 35°C, 80% relative humidity). Physical fitness tends to decrease with age because the average level of physical activity declines. More strain is placed on the cardiovascular system and less cardiovascular reserve is left, because any activity performed becomes more stressful. The cardiovascular reserve is especially relevant to the capacity for thermoregulation, as it determines the capacity to move heat for dissipation from the body core to the skin by blood flow. Decline in fitness can cause a vicious circle, as the increased strain experienced with activity may promote even further reduction in activity, which again may further reduce fitness. Exposure to heat and cold is avoided, which leads to a loss of acclimatization to heat and cold. These changes reduce muscle strength, work capacity, the ability to transport heat from the body core to the skin, hydration levels, vascular reactivity and cardiovascular stability (blood pressure) among elderly people. These effects predispose elderly people to higher risk, leading to an increase in morbidity and mortality.

Overweight :

Overweight is another factor that increases the risk of heat-related illnesses and is often correlated with low fitness levels. The thermal conductivity of fatty tissues is lower than that of other tissues in the body e.g. muscles. Subcutaneous tissue is, therefore, an insulation barrier to conductive heat flow. In an obese person, less heat can be produced per unit mass before the temperature of the core tissues increases. To dissipate heat, obese people have to direct more blood flow through the subcutaneous vessels, and obese people therefore have higher cardiovascular strain and higher heart rates when exposed to heat stress. For these reasons, obese people are more susceptible to moderate heat stress, injuries and heat stroke. However, the difference in heat strain between obese and lean individuals appears to diminish when air temperature exceeds skin temperature. When environmental temperatures surpass skin temperatures, the lean individual will gain heat through radiation and convection at a quicker rate per unit mass. Anthropometric measures and body composition significantly but secondarily influence physiological responses, such as Mean Arterial Blood Pressure (MABP), forearm blood flow and forearm vascular conductance.

Symptoms of heat stress :

Dizziness or fainting	Extreme thirst
Nausea or vomiting	Decreased urination with usually dark yellow urine
Headache	Rapid breathing and heartbeat

Prevention : Immediately move to a cool place and drink liquids. **Water is best,** get medical attention, measure your body temperature.

If one experiences **painful muscular spasms** (particularly in the legs, arms or abdomen, after sustained experience during very hot weather) :

- Rest immediately in cool place, and drink oral rehydration solutions containing electrolytes.
- Medical attention is needed if heat cramps last more than one hour.

Heatstroke is medical emergency : Be aware of Danger Signs

In adults	In children
• Altered mental sensorium with disorientation, confusion and agitation, irritability, ataxia, seizure or coma • Hot, red and dry skin • Core body temperature ≥ 40°F or 104°F • Throbbing headache • Anxiety, Dizziness, fainting and light headedness • Muscle weakness or cramps • Nausea and vomiting • Rapid heartbeat/Rapid, shallow breathing	• Refusal to feed • Excessive irritability • Decreased urine output • Dry oral mucosa & absence of tear/sunken eyes. • Lethargy/altered sensorium • Seizures • Bleeding from any site

While waiting for assistance, cool the person immediately by :

- Moving them to a cool place
- Applying cold water to large areas of the skin or clothing
- Fanning the person.

Do's

Stay adequately Hydrated :

- Drink sufficient fluids whenever possible, even if you are not thirsty. Thirst is not good indicator of dehydration.
- Carry drinking water in thermos flask when travelling.
- Use Oral Rehydration Solution (ORS), and consume homemade drinks like lemon water, butter milk/lassi, fruit juices with some added salt.
- Eat seasonal fruits and vegetables with high water content like water melon, musk melon, orange, grapes, pineapple, cucumber, lettuce or locally available fruits and vegetables.

Stay Covered :

- Wear thin loose, cotton garments preferably light coloured.
- During exposure to direct Sunlight cover your head: use umbrella, hat, cap, towel, traditional head gears.
- While going out in Sun, wear shoes or chappals.

Stay alert : Listen to Radio; watch TV; read Newspaper for local weather news. Get the latest update of Weather on Indian Meteorological Department (IMD) website at https://mausam.imd.gov.in/

Stay indoors as much as possible : In well ventilated and cool places.

- Block direct sunlight and heat waves : Keep windows and curtains closed during the day, especially on the sunny side of your house. Open them up at night to let cooler air in.
- If going outdoor, limit your outdoor activity to cooler times of the day, i.e. morning and evening.
- Reschedule or plan outdoor activities during cooler parts of the day.

For vulnerable population : Infants and young children, Pregnant women, People working outdoors, People who have a mental illness, People who are physically ill, especially with heart disease or high blood pressure, People coming from cooler climate to a hot climate :

If such persons are visiting during heatwave, they should allow one week's time for their bodies to acclimatize to heat and should drink plenty of fluids. Acclimatization is achieved by gradual increase in exposure/physical activity in hot environment.

- Elderly or sick people living alone should be supervised and their health monitored on a daily basis.
- Keep your home cool, use curtains, shutters or sunshade and open windows at night.
- Try to remain on lower floors during the day.
- Use fan, damp cloths to cool down body.

Don'ts

- Avoid getting out in the Sun, especially between 12.00 noon and 03.00 pm.
- Avoid strenuous activities when outside in the afternoon.
- Do not go out barefoot.
- Avoid cooking during peak summer hours. Open doors and windows to ventilate cooking area adequately.
- Avoid alcohol, tea, coffee and carbonated soft drinks or drinks with large amount of sugar – as these actually, lead to loss of more body fluid or may cause stomach cramps.
- Avoid high-protein food and do not eat stale food.
- Do not leave children or pets in parked vehicle. Temperature inside a vehicle could get dangerous.

For employers and workers :

- Provide cool drinking water at work place and remind them to drink a cup of water every 20 minutes or more frequently to stay hydrated.
- Caution workers to avoid direct Sunlight.
- Provide shaded work area for workers. Temporary shelter can be constructed at work site.
- Schedule strenuous and outdoor jobs to cooler times of the day, i.e. morning and evening hours.
- Increase the frequency and length of rest breaks for outdoor activities – at least every 5 minutes after 1 hour of labour work.
- Listen to Radio; watch TV; read Newspaper for local weather news and act accordingly. Get the latest update of weather on Indian Meteorological Department (IMD) website at https://mausam.imd.gov.in/
- Make sure everyone is properly acclimatized : it takes weeks to acclimatize to hotter climate. Do not work for more than three hours in one day for the first five days of work. Gradually increase the amount and time of work.
- Train workers to recognize factors which may increase the risk of developing a heat related illness and the signs and symptoms of heat stress and start a "buddy system" since people are not likely to notice their own symptoms.
- Trained First Aid providers should be available and an emergency response plan should be in place.
- Pregnant workers and workers with a medical condition or those taking certain medications should discuss with their physicians about working in the heat.
- If working outdoors, wear light-coloured clothing preferably long sleeve shirt and pants, and cover the head to prevent exposure to direct sunlight.
- Organize awareness campaigns for employees.
- Install temperature and forecast display at the workplace.
- Distribute informational pamphlets and organize training for employers and workers regarding health impacts of extreme heat and recommendations to protect themselves during high temperatures

Indian Meteorological Department (IMD) issues following colour code impact based heat warning jointly with National Disaster Management Authority (NDMA) :

Colour Code	Alert	Warning	Impact	Suggested Actions
Green (No action)	Normal Day	Maximum temperatures are near normal	Comfortable temperature. No cautionary action required.	Nil
Yellow Alert (Be updated)	Heat Alert	Heat wave conditions at isolated pockets persists on 2 days	Moderate temperature. Heat is tolerable for general public but moderate health concern for vulnerable people, e.g. infants, elderly, people with chronic diseases	(a) Avoid heat exposure. (b) Wear lightweight, light coloured, loose, cotton clothes. (c) Cover your head: Use a cloth, hat or umbrella
Orange Alert (Be prepared)	Severe Heat Alert for the day	Severe heat wave conditions persists for 2 days Through not severe, but heat wave persists for 4 days or more	High temperature. Increased likelihood of heat illness symptoms in people who are either exposed to sun for a prolonged period or doing heavy work. High health concern for vulnerable people, e.g. infants, elderly, people with chronic diseases.	(a) Avoid heat exposure– keep cool. Avoid dehydration. (b) Drink sufficient water- even if not thirsty. (c) Use ORS, homemade drinks like lassi, torani (rice water), lemon water, buttermilk, etc. to keep yourself hydrated
Red Alert (Take Action)	Extreme Heat Alert for the day	Severe heat wave persists for more than 2 days. Total number of heat/severe heat wave exceeding 6 days.	Very high likelihood of developing heat illness and heat stroke in all ages.	Extreme care needed for vulnerable people.

Sd/
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