

Protecting Children from Heat Stress

A technical note



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Foreword

Climate change is threatening the basic rights of children: to survive, thrive and reach their full potential.

By raising average global temperatures and increasing the frequency, intensity and duration of heatwaves,¹ climate change is exposing populations everywhere to heat stress, which is contributing to significant negative health outcomes particularly for infants, children, pregnant women, the elderly, outdoor workers and other vulnerable people. For infants, young children, and pregnant women, greater heat stress is increasing the risk of adverse birth outcomes, chronic health issues and infant deaths.² The most at-risk are the most deprived.

The world is responding to these challenges. Many governments are taking the lead in developing and implementing policies and action plans to address heat stress. Even so, there is limited attention to the specific vulnerabilities of pregnant women and children, and the measures that should be taken to support them.

To protect children's health, development and well-being from this and other environmental challenges, UNICEF launched the [Healthy Environments for Healthy Children](#) global programme framework in 2021. As part of the framework, this note aims to improve the understanding of how heat stress impacts pregnant women, infants, children and adolescents; identify the symptoms of heat stress; and suggest interventions to support prevention, diagnosis, care and treatment to protect children's health and well-being.

The note is based on existing global evidence, best practices, and inputs from leading experts. We trust that UNICEF country offices, programme partners, and health and climate professionals will find this note a useful companion as they tackle these issues on the ground. We also hope that this technical note along with country experiences will inform and help shape formal global guidance on this critical issue.

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For more information, please visit: <https://www.unicef.org/health/healthy-environments>

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Introduction: Climate change is causing more heatwaves, and children are increasingly exposed

The world has made tremendous progress for children by reducing the under-five mortality rate by 59 per cent in the last three decades.³ Climate change, however, poses a looming threat to reverse this trend. Climate risks are universal but are more concentrated in low- and middle-income countries, in poorer, marginalized communities in all countries, and especially among children.⁴

Human-induced activities have increased carbon emissions over the last century, accelerating climate change and raising the average global temperature to an alarming level.⁵ Global warming has exacerbated extreme shocks such as hurricanes and floods and increased the frequency and intensity of extreme heatwaves around the world, and prolonging periods of extreme heat. According to the Institute of Health Metrics and Evaluation, in 2019 alone, 308,000 deaths were attributable to exposure to high temperatures.⁶

Resources

The Coldest Year of the Rest of their Lives: A 2021 UNICEF report releasing global data on child exposure to heatwaves under various emission scenarios.

'The 2022 Report of the Lancet Countdown': A seminal effort to track the relationship between health and climate change across five key domains, including heatwaves and related stress.

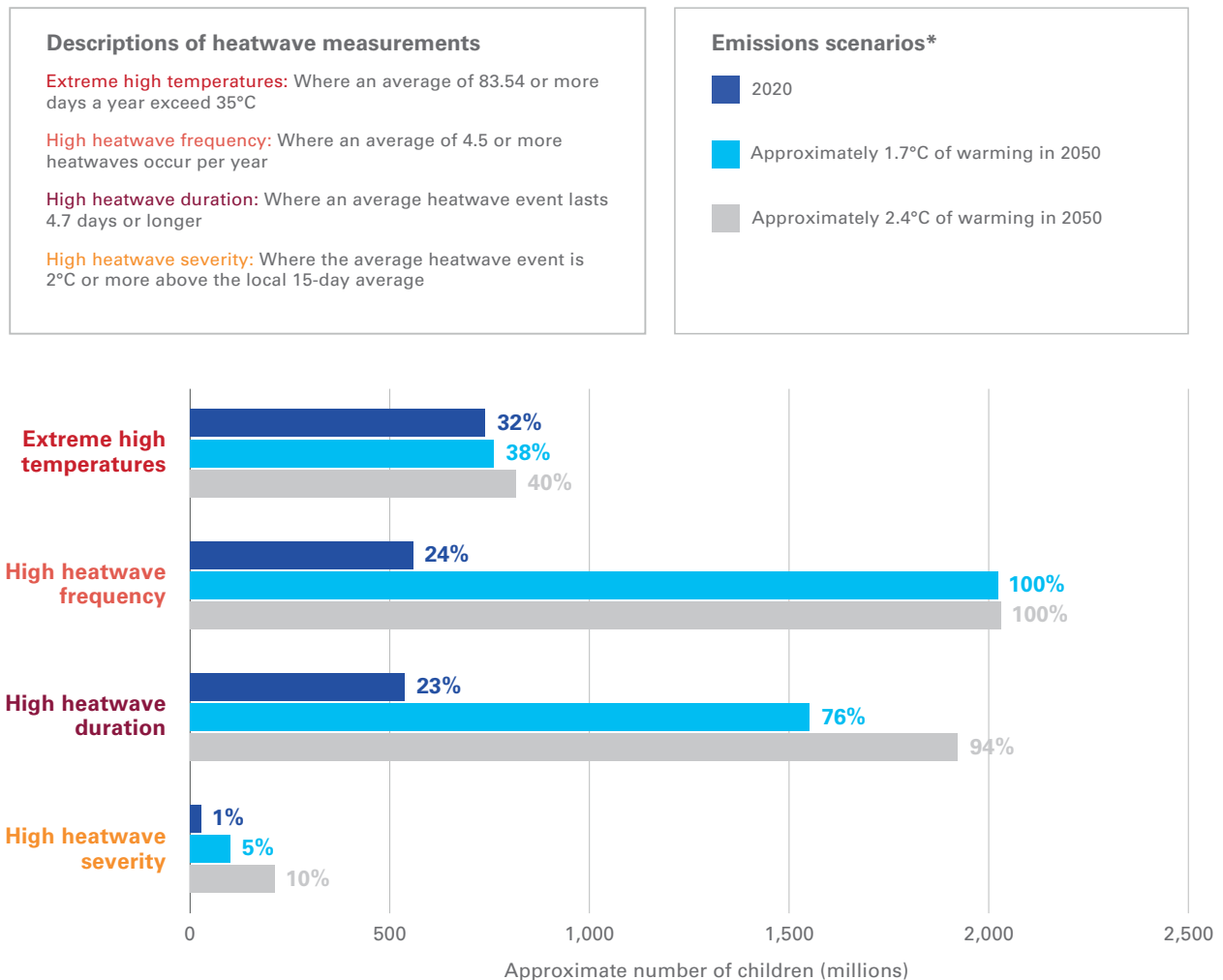
'Global Burden of Disease': A regularly updated database of global health burdens based on existing data and models, managed by the Institute of Health Metrics and Evaluation, a global health statistics and impact evaluation organization.

Healthy Environments for Healthy Children: UNICEF's global programme framework for protecting children's health from the impact of climate change and environmental degradation.

The UNICEF report *The Coldest Year of the Rest of Their Lives* found that by 2050 **almost every child under 18 in the world – nearly 2.2 billion – will be exposed to high heatwave frequency, up from only 24 per cent of children in 2020.**⁷ According to the same report,

approximately 559 million children are already exposed to high heatwave frequency and around 624 million children are exposed to one of the three other high-heat measures: high heatwave duration, high heatwave severity or extreme high temperatures (see Figure 1).

Figure 1 Percentage of children worldwide affected by different heatwave measurements, and projections based on various emission scenarios



* 2020 percentages are based on 2020 population, while the 2050 percentages are based on projected 2050 population

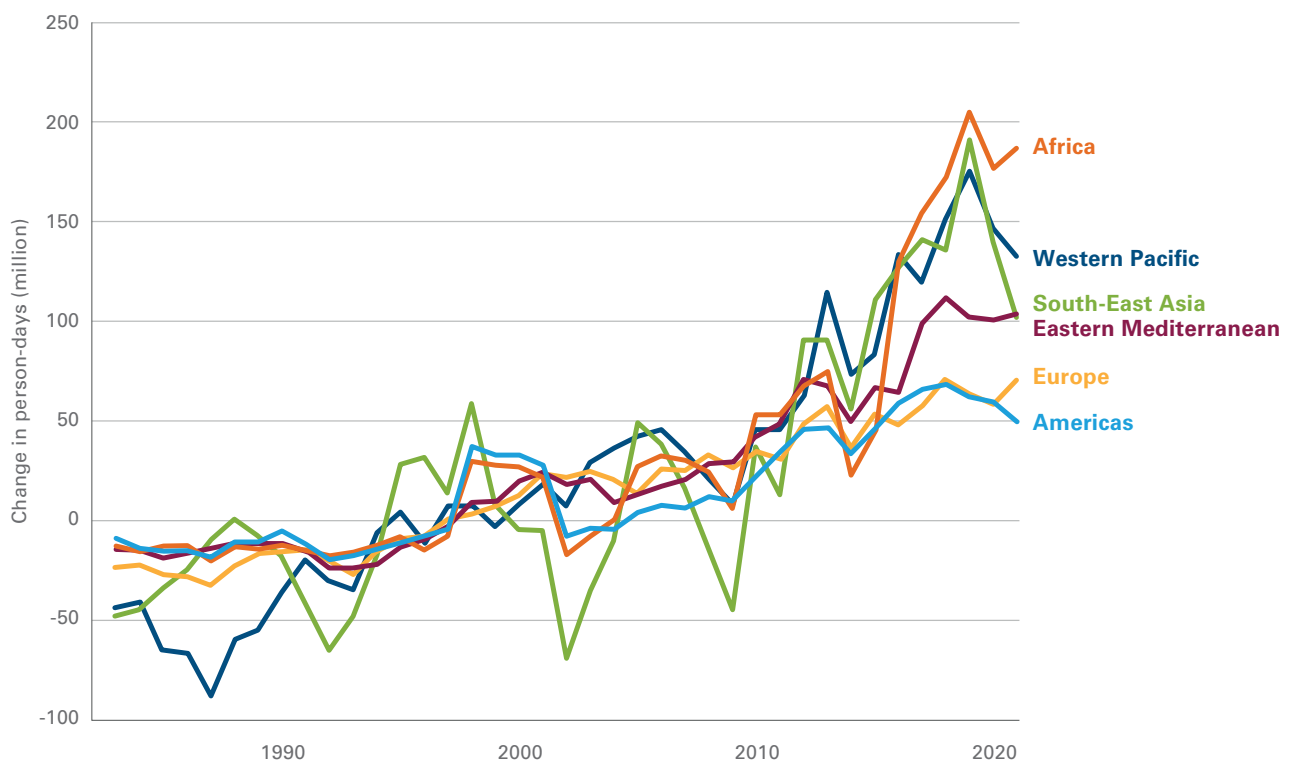
Source: UNICEF, 2022

In 2020, around 740 million children (1 in 3 globally) lived in countries with 83 or more days per year exceeding 35°C/95°F.⁸ Child exposure to extreme high temperatures is currently the highest in Africa and Asia; this will still be the case by 2050.

According to the *Lancet* Countdown report, from 2000 to 2021, global populations were exposed to an average increase in summer

temperatures two times higher than the global mean.⁹ It also found that children under 1 year old experienced a total of 600 million more person-days (e.g., if 100 people are each exposed for five days, there would be 500 person-days) of heatwaves in this period than in 1986–2005. Figure 2 below shows that these effects are not being felt equally, as children in Africa are living through more person-days of heatwaves than other groups.

Figure 2 Exposure of infants (under 1 year old) to heatwaves



Source: Romanello et al., '2022 Report of the *Lancet* Countdown'.

Exposure to extreme heat, including during heatwaves, is becoming a global experience and is likely to become more severe and frequent in the medium term, even if mitigation measures meet the goals of the Paris Agreement by 2030.

Therefore, a primary health care approach is the key to protect children, pregnant women and other vulnerable populations from the impact of heat stress generated by exposure to extreme heat. This approach

The Paris Agreement

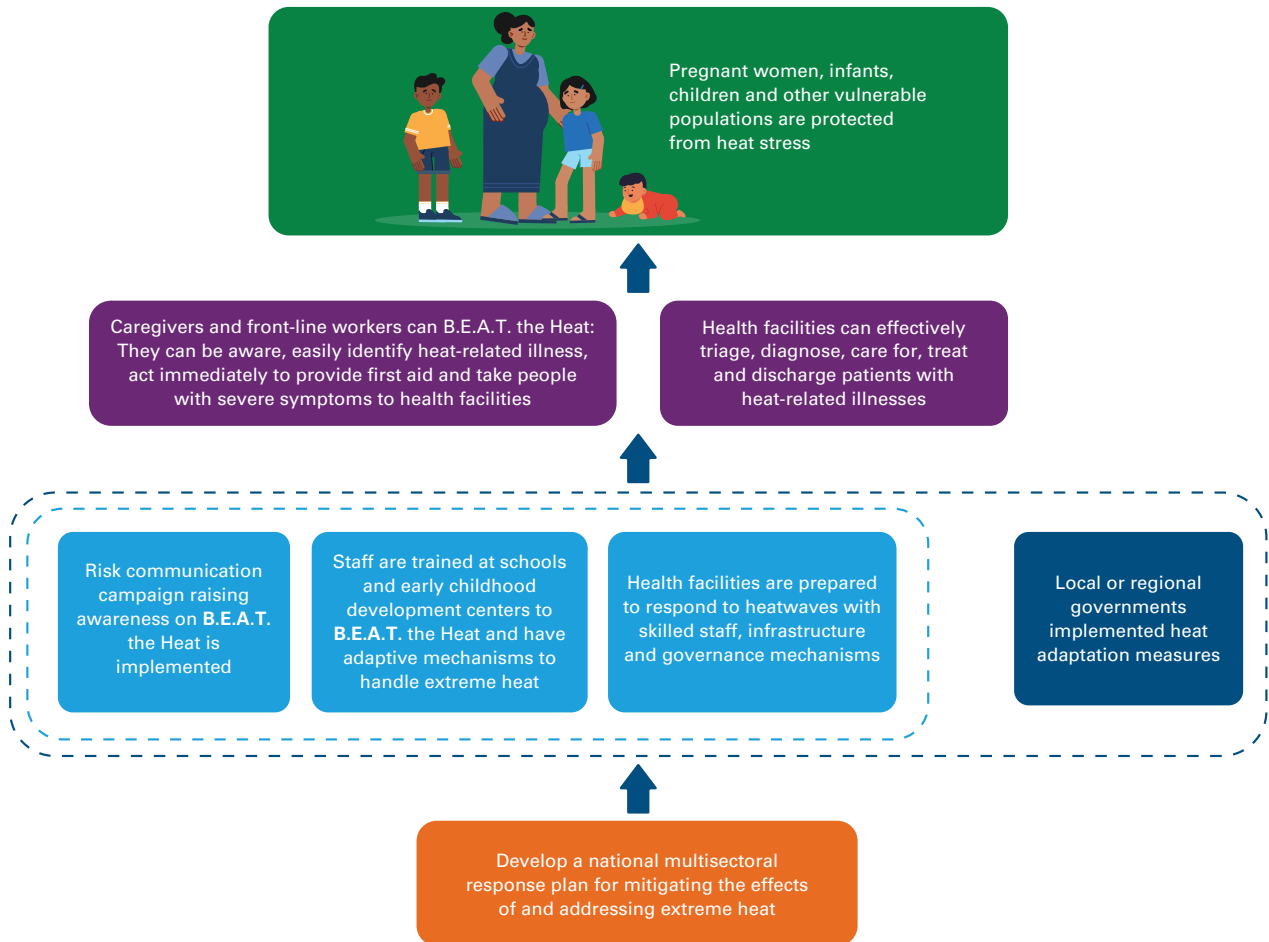
The Paris Agreement, or the Paris Climate Accords, was adopted in 2015 as an international climate treaty by 196 parties at the United Nations Climate Change Conference (COP21). Parties committed to a range of goals, the most important being limiting temperature rise to 'well below' 2°C.

includes essential public health functions, empowered people and communities, and multisectoral policy and action.

To prevent and minimize detrimental health outcomes, the primary health care approach can use the following framework (see Figure 3) to inform

efforts to address the effects of heat stress – particularly mild and severe heat-related illnesses (HRIs) – in vulnerable populations.

Figure 3 Framework for protecting children from heat stress



Know the facts: Pregnant women, infants and children are uniquely vulnerable to heat stress

Exposure to extreme heat can result in short- and long-term illnesses and development setbacks, particularly in vulnerable populations such as pregnant women, infants, children, the elderly and outdoor workers. Extreme heat – periods of abnormally hot weather¹⁰ – can also exacerbate existing burdens of disease by further stressing the immune and nervous systems and overwhelming their capacities to maintain proper internal body temperature. Protecting these vulnerable populations is critical as certain regions are already being exposed to an average increase in annual temperature twice the rate of the global average.¹¹

The risk of HRI caused by excessive or unmanageable heat stress in the body is driven by a set of factors that define vulnerability: **heat exposure** (ambient and internally generated heat, modulated by humidity, airflow and geography), **individual susceptibility** (influenced by age, pregnancy status, comorbidities and disabilities), **socio-cultural factors** (including poverty, lack of basic services, lack of social cohesion

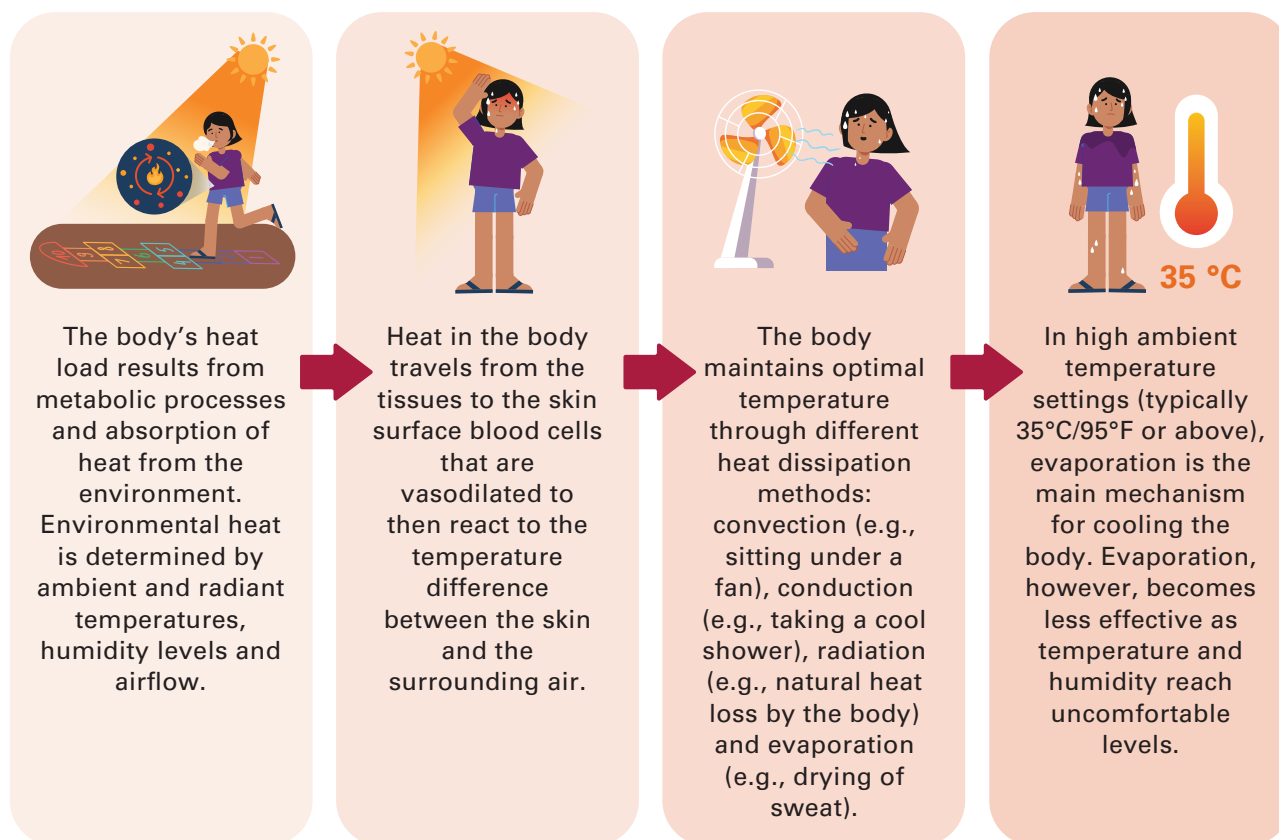
and limited worker protections) and **control over decision making**.

The main physiological mechanisms for thermoregulation – or maintaining heat balance – during heat events are radiation, convection, conduction and evaporation. These take effect once heat in the body travels from tissue cells to vasodilated cells, where blood vessels are widened to increase blood flow, in the skin's surface. When heat loads cannot be properly regulated by the body, often due to high temperatures and humidity, the resulting heat stress can induce a "cascade of biological and physiological reactions with detrimental effects for maternal and perinatal health, including the neonatal period"¹² (see [Figure 4](#)).

What is heat stress?

Heat stress occurs when the body is unable to remove excess heat, resulting in adding stress to the body. This can lead to the body experiencing HRIs and can also make it harder for the body to respond to existing vulnerabilities.

Figure 4 How the body can become overheated



Pregnant women: Vulnerability and impact of exposure¹³

Pregnant women and fetuses are particularly vulnerable to the effects of extreme heat. Heavily pregnant women – those in their second and third trimesters – are considered vulnerable to extreme heat due to physiological changes that occur during pregnancy. Exposure to extreme heat has been linked to labour complications, high blood pressure and eclampsia, as well as preterm birth. For instance, a review of hospitalizations of pregnant women in the United States of America found that the odds of hospitalization rose by almost 5 per cent for each additional day a pregnant woman spent in extreme heat during the second trimester, and by 3 per cent during the third trimester.¹⁴

The energy demands of a growing fetus are likely to generate heat within the body of the pregnant woman, thereby slightly increasing her own core body temperature.¹⁵ In addition, dehydration from increased sweating was found to trigger early labour.¹⁶ Exposure to extreme heat while pregnant was also found to affect the genetic and

Higher risk for working pregnant women

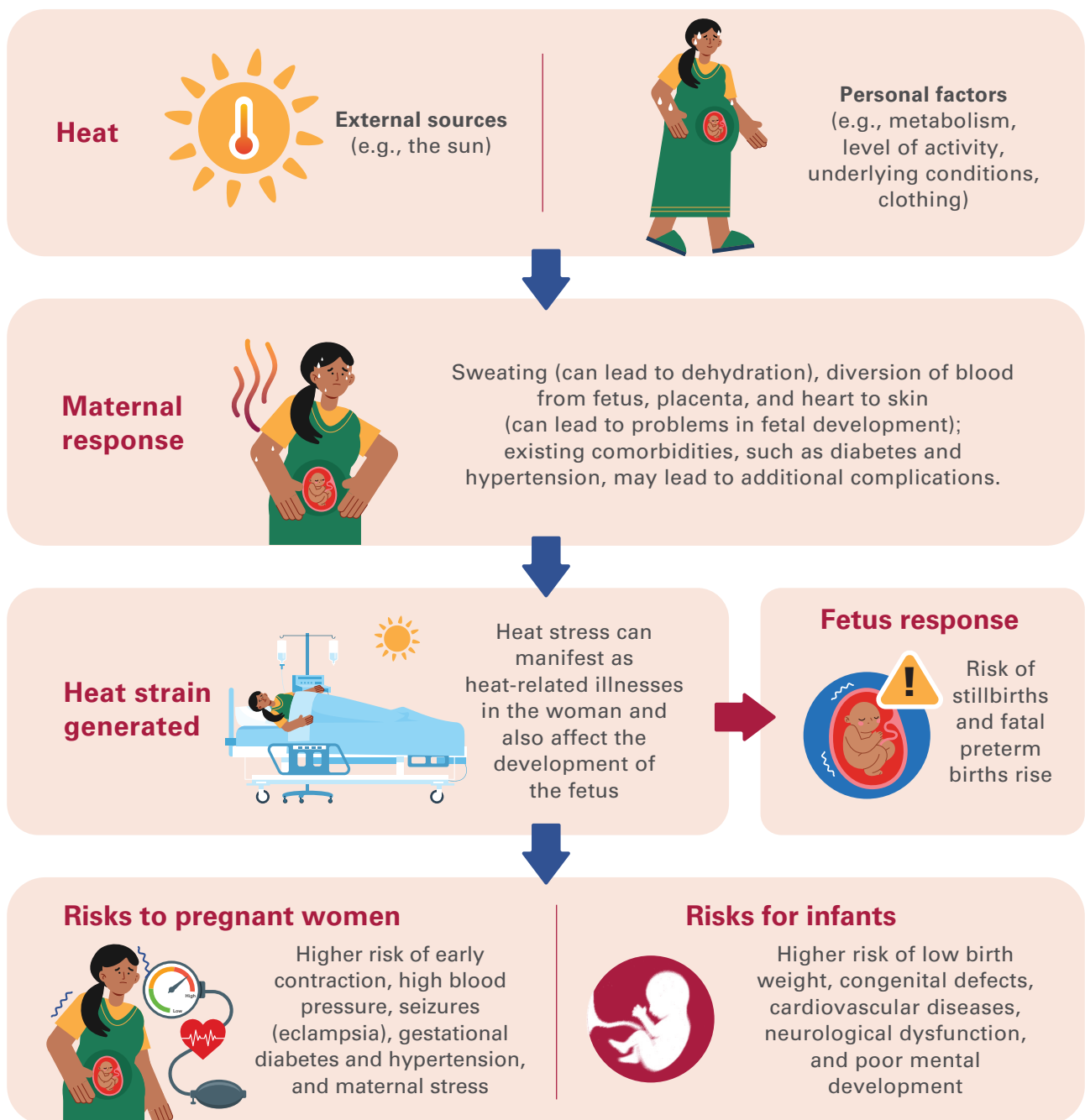
Human Rights Watch has drawn attention to the fact that pregnant workers face “increased risk of heat stress” as physical labour in high temperatures can require greater physical exertion and therefore increase the core body temperature.

A 2022 study in the Gambia also found that all pregnant women who participated experienced significant heat stress while working outdoors.

protein make-up of the fetus, leaving it less capable of fighting off the effects of heat stress. This has been observed to be more likely during the first trimester of pregnancy, when the fetus is most sensitive to changes in heat.¹⁷ In addition, increases in temperature during labour have been associated with neonatal brain injury.¹⁸

Therefore, unaddressed heat stress, including when the mother is asymptomatic, is likely a contributing factor to increased mortality and morbidity rates in infants,¹⁹ as well as the mothers. A potential pathway for how heat stress is translated from the mother to the fetus is demonstrated in Figure 5 below; evidence of the specific mechanisms is still being generated.

Figure 5 Maternal physiological responses to heat stress and effects on fetal development



Source: Adapted from Bonell et al., 'Environmental Heat Stress on Maternal Physiology'.

Significant findings have been made on the impacts of heat stress on pregnancies and fetal development, including:

- The odds of a preterm birth rose by 5 per cent per 1°C increase in temperature, and by 16 per cent during heatwave vs. non-heatwave days, demonstrating that the odds are sensitive to dose response – i.e., greater exposure²⁰ and severity result in greater risk.²¹
- A meta-analysis showed associations between temperature exposure during pregnancy and stillbirth, with odds of stillbirth rising 5 per cent per 1°C increase in temperature.²²
- Women who give birth during extreme heat periods may be more likely to have neonates with illnesses. In Bangladesh, women were 14 per cent more likely to have newborns with neonatal illnesses when giving birth on hot days, compared to those giving birth on cooler days.²³
- Heat stress can trigger fetal tachycardia, development of congenital defects, and fetal distress during fetal development.²⁴
- Dehydration, which is more likely to occur during high-heat periods, can lead to serious complications during pregnancy and the postpartum period, including reduction of the levels of amniotic fluid and poor production of breast milk. Dehydration may also represent a trigger for preterm birth.²⁵
- A 2019 study found that pregnant women were more likely to be hospitalized when exposed to extreme heat during their second and third trimesters.²⁶
- Exposure to extreme heat during the first half of pregnancy has been associated with greater risk of pre-eclampsia and gestational hypertension,^{27, 28} as well as gestational diabetes.²⁹

Infants and children: Vulnerability and impact of exposure

Compared to adults, infants and children are uniquely affected by heat stress, leaving them more vulnerable to its short- and long-term effects. This is due to particular physiological characteristics:³⁰

- **Higher heat production:** Because they have more internal heat to begin with and move less economically per given activity, children produce more heat per kilogram of weight than adults do.^{31, 32, 33}
- **Greater body surface area:** Younger children have a higher surface-area-to-mass ratio. This can lead them to absorb more heat from the environment, depending on their body and fitness levels.³⁴ Conversely, this may be useful for heat dissipation in other environments.
- **Lower levels of sweat production:** Children have a lower rate of sweating than adults do because of a lower sweat rate per gland, and they begin sweating at a higher body temperature.^{35, 36}
- **Under-developed bodily systems:** Infants experiencing heat stress are likely less capable of fighting off the symptoms, as they have under-developed sweat glands and less capacity for regulating their temperature independently. They also have a developing immune system, which potentially further diminishes their capability.³⁷ In addition, heat stress in pregnant mammals was observed in recent studies to impair the immunological function of the offspring, further hindering the offspring's ability to regulate extra heat.^{38, 39}
- **Cellular modification:** When pregnant women experience heat stress, the stress placed on the fetus could affect its ability to synthesize proteins properly, through affecting heat shock protein development, thereby leaving the child more vulnerable to developing physical defects and illnesses.^{40, 41}

- **Slower adjustment to changes in weather:** Infants and young children adapt to changes in temperature more slowly than adults,^{42, 43} thus making them more vulnerable to extreme shifts such as heatwaves,⁴⁴ in part because they have poorer blood circulation and lower proportional cardiac output⁴⁵ compared to adults.⁴⁶ Infants and young children adapt to a hot environment more slowly than adults do, typically requiring 10–14 days to achieve adequate acclimatization.⁴⁷ Similarly, when exercising, children and adolescents require 10–14 days to become acclimated, compared to 7 for adults with comparable activity per day.⁴⁸
- **Poorer practice of fluid replenishment:** If not appropriately supervised, children are more likely to inadequately replenish fluid losses during prolonged exercise.⁴⁹

Impacts that have been found to be associated with exposure to heat stress include:

Newborns and infants

- In meta-analysis, exposure of pregnant women to higher temperatures was associated with reduced birth weight of neonates.^{50, 51}
- Newborns have a greater risk of being born with various congenital defects, including congenital heart defect, spina bifida and cranio-facial defects.^{52, 53} In a US-based study, the largest increase in specific defect types was correlated with early pregnancy periods in the spring. This is likely due to slow acclimatization of pregnant women to the shifting heat levels.⁵⁴

Neonates are particularly vulnerable

According to a 2017 systematic review on the effects of heat on pregnancy outcomes, “up to 40.3% of deaths in children under five years of age occur in neonates” and “preterm births account for 35% of neonatal mortality worldwide”.

- Heat can lead to jaundice, neurological dysfunction and dehydration in infants.⁵⁵
- Some studies and reviews have suggested a link between exposure to heat stress and an increased risk of sudden infant death syndrome^{56, 57} (2004 disclaimer⁵⁸).
- Infants are breastfed for shorter periods of time during the hottest days of the year compared to the coldest, which can affect the nutritional status of the infant.⁵⁹ In addition, studies are finding that heat exposure, stunting and wasting are likely linked directly.^{60, 61}

Children and adolescents

- According to a 58-country assessment, each additional day above 26.7°C (80°F) during the three years preceding an exam lowered scores by 0.18 per cent of a standard deviation, with the effect larger for lower-income populations.⁶² Another study found that, without air conditioning, each 0.56°C (1°F) increase in school-year temperature reduces the amount learned that year by 1 per cent.⁶³
- Every additional day with mean temperatures above 32°C (89.6°F) in utero and in the first year after birth is associated with a 0.1 per cent reduction in adult annual earnings at age 30.⁶⁴

Focus on prevention: Introducing the ‘B.E.A.T. the Heat’ communication framework

There is a growing urgency and need to address heat stress. A primary health care approach is key to enacting prevention, early action, diagnosis, care and treatment, and the combined efforts of caregivers, communities and front-line workers will be essential. Front-line workers include community health workers, teachers, early child development (ECD) caregivers, midwives, nurses and doctors.

Together, front-line workers will be able to help communities ‘B.E.A.T. the Heat’, a risk communication framework.

Importance of community health workers

Example from Karachi, Pakistan

A community health worker-led heat education programme was associated with a **38 per cent reduction in hospital visits for any cause**, including heat stress. It was concluded that a community health worker-led community intervention was associated with decreased unscheduled hospital visits and improved heat literacy and practices. [Click here](#) to read more about it.

Study from the United States on the role of social cohesion in climate adaptation

More and more studies are showing that strong social networks are an important factor in saving lives in the midst of climate shocks and stresses, including heatwaves. In communities in many countries, front-line workers are part of these networks. [Click here](#) to read more about it.

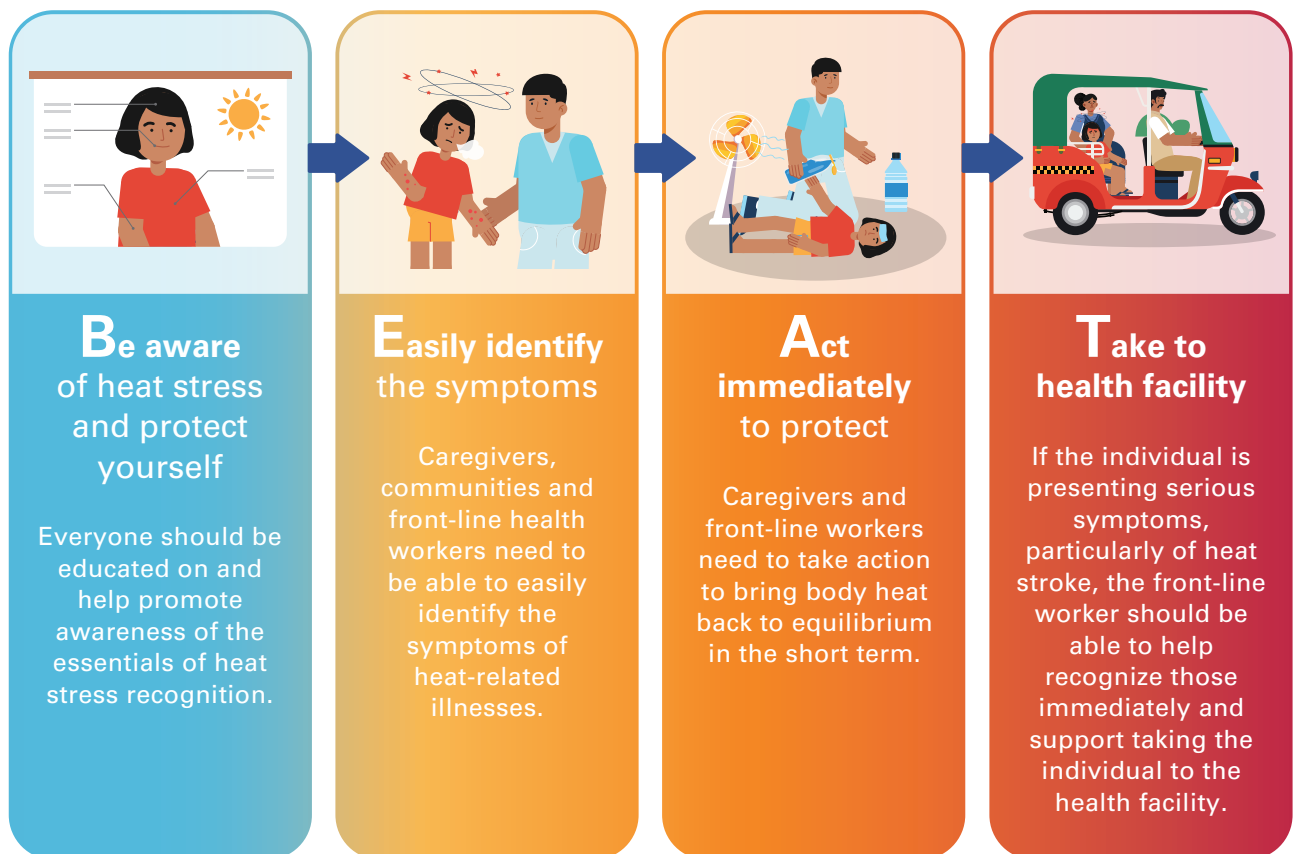
B.E.A.T. the Heat

BE AWARE of heat stress and protect yourself: Recognize heat stress and know what actions to take;

EASILY IDENTIFY the symptoms: Recognize the symptoms of various heat-related illnesses that caregivers, communities and front-line workers need to know;

ACT IMMEDIATELY to protect: Learn the first-aid actions that caregivers and front-line workers need to take to rebalance body heat in the short term; and

TAKE to a health facility: If an individual is showing **serious** symptoms, especially signs of heat stroke, front-line workers, community stakeholders and caregivers should recognize the symptoms immediately and help take the individual to a health facility.



BE AWARE of heat stress and protect yourself

The most effective interventions help prevent HRIs from happening. This section outlines a set of key messages on what caregivers, communities and front-line workers need to know about heat stress and the preventive actions they can take. This is an important step for HRI prevention because front-line workers hold strong connections with the communities they support, and thus, they

can act as trusted and effective sources of information dissemination.

The following messages can be disseminated during awareness campaigns that target the general public, caregivers and front-line workers such as teachers, community health workers, transportation workers and other public personnel.

Know that excess heat is dangerous to one's health, especially for infants, children, pregnant women and the elderly.:

1. Too much heat is dangerous for one's health, especially for infants, children, pregnant women and the elderly.
2. Heat stress can cause mild health issues, like dehydration and higher body temperature, as well as severe issues, such as cardiovascular diseases, organ failure, muscle and nerve dysfunction, and even death.
3. Heat combined with humidity can make dehydration worse. Sweating depletes not only water, but also important salts the body needs.
4. Children's bodies have more trouble regulating temperature than those of adults, and they rely on adults to help protect them from heat.
5. Heat stress in pregnancy can put the baby at risk of low birthweight, early birth and even stillbirth.
6. Heat stress in infants can lead to infections and even death.
7. Severe symptoms of heat stress require urgent care. These symptoms include confusion or inability to respond, fainting, high body temperature, rapid heartbeat or breathing, seizures and even loss of consciousness.
8. Additional serious symptoms in infants can include sunken forehead and eyes.
9. Additional serious symptoms in pregnant women can include early contractions or intense cramping.
10. **Trust your instincts!** If it seems like someone is not behaving normally when it is hot outside, take them to a health facility.

Know how to protect yourself, your family and your community from heat stress:

1. Know how hot and humid it is going to get today, this week and this month to help plan outside activities.
2. Avoid going out at the hottest times of the day. Remember that the temperature on weather stations is always in the shade.⁶⁵
3. Know how to get help. Know important contact information for the nearest health care provider or ambulance/transport services and use it to receive help as soon as necessary.
4. Protect the vulnerable and yourself. Stay in the shade, drink water before feeling thirsty, and rest! If your community has a cooling centre, use it.
5. Have everyone wear light, loose, breathable fabrics and use sunscreen. Cotton is ideal during hot weather to help reduce heat rashes and absorb sweat. Use umbrellas and hats outside for protection.
6. Choose water for rehydration over coffee, tea or soft drinks. Caffeine, alcohol and sugar can affect sleep and well-being.
7. Keep an emergency kit at home containing towels, oral rehydration salt (ORS) packets and a thermometer. Give ORS mixed into water to anyone with extreme sweating, especially children who might have played outside.
8. Close the curtains during the hottest parts of the day, open windows when it is hotter inside than outside and use fans and coolers when available. In dry heat, fans can be used along with wet towels or misting the body.⁶⁶
9. Ensure that infants, pregnant women and other vulnerable populations sleep in cooler areas, such as lower floors of the house or building. Use cotton sheets for bedding.
10. Check on your neighbours and share information, particularly if they have young children, pregnant women, or elderly individuals. Support efforts that encourage protection of vulnerable workers from heat exposure.



Know the special measures to protect young children and pregnant women:

1. Check regularly to see if your child is thirsty, sweating, feeling hot, vomiting, has a dry and sticky mouth, or is experiencing headaches.
2. Wrap infants loosely – this can help prevent heat rashes and overheating and avoid severe symptoms.
3. Breastfeed infants under 6 months exclusively. Breastfeeding mothers should drink plenty of water as dehydration can affect breastmilk production.
4. Never leave infants or children in closed spaces without ventilation (such as cars, rooms with closed windows or enclosed prams).
5. Do not give infants showing signs of being overheated any medication without consulting a health provider.⁶⁸
6. Pregnant women should avoid going out when it is hot (above 40°C/104°F). Pregnant women can exercise with low or moderate intensity as long as they are feeling comfortable and are hydrating and resting properly.
7. Pregnant women must rest when possible and share workloads with others when possible.
8. Do not let your children play outside for a long time when it is hot. Keep an eye on them and have them rest every 30 minutes when exercising or playing outside. Exercising or playing in high temperatures can quickly lead to dehydration and serious consequences.
9. Ensure that all children aged 6 months and over are drinking water regularly throughout the day. They may not be paying attention to their bodies, so adults need to help them stay hydrated.
10. Remember: Severe symptoms require urgent care.

These messages can be complemented by the list of signs and symptoms with which front-line workers and caregivers should become familiar (see Table 1).

EASILY IDENTIFY the symptoms

For front-line workers and caregivers to address heat stress quickly, they must first know the signs and symptoms of the various manifestations of heat stress.

Table 1 summarizes how various forms of heat stress can manifest in paediatric and pregnant populations. These symptoms should become familiar to front-line workers and caregivers, and can be distributed in the form of a checklist to be carried around during house visits or placed in classrooms and preschool centres.

The most important heat-related symptom to be aware of is an altered mental state, which is a symptom of heat stroke.

Altered mental status can include symptoms such as delusions, confusion, inability to respond clearly, seizures, extreme lethargy/slowness and even a coma. Individuals

Understanding common symptoms in your community

While symptoms can be complex and varied from person to person and between age groups, there are some signs that are easier to assess, especially by community health workers making household visits during heatwaves. The most common symptoms, as assessed in [one study in India](#), were “headaches, heavy sweating, fatigue, intense thirst, dry mouth and small blisters/rash”.



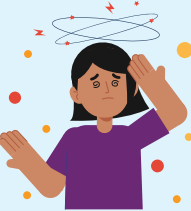

with altered mental status should be cooled down immediately and taken to the hospital as soon as possible.

Using this consolidated list, caregivers and front-line workers should be able to differentiate between mild HRIs and heat stroke, the most severe HRI and the one requiring immediate medical attention.



Table 1 Signs and symptoms of HRIs in children and pregnant women⁶⁹

 High severity and urgency

| Population | Milder symptoms (Treat at home) | Severe symptoms (Take to hospital immediately) |
|--|---|--|
|  <p>General Population</p> | <ul style="list-style-type: none"> • Dry lips, sticky mouth • Excessive thirst • Excessive sweating • Weakness, dizziness • Nausea, vomiting • Small blisters, rashes • Heat rashes • Mild, slightly high body temperature • Cramps, usually in arms and legs • Nosebleeds (common in hot and dry environments) | <ul style="list-style-type: none"> • Confusion/not responding clearly, seizures, coma, very dull, not waking up (MOST SEVERE) • Very high body temperature for longer than two hours (40°C/104°F) • Fainting • Dark urine • No urine in more than eight hours • Rapid heartbeat and breathing • No sweating (but skin may be wet and hot) |
|  <p>Specific to Infants and Young Children (up to 4 years of age)</p> | <ul style="list-style-type: none"> • Heat rashes in diapered area • Irritable and/or crying | <ul style="list-style-type: none"> • Crying without tears • Sunken eyes and/or forehead • Vomiting or diarrhoea • Extreme irritability • Fewer wet diapers |
|  <p>Specific to Older Children and Adolescents (approximately 4–19 years of age)</p> | <ul style="list-style-type: none"> • Expresses nausea • Expresses having headaches • Muscle cramps (especially after exercising outside, which is common for this age group) | <ul style="list-style-type: none"> • Deep or severe muscle pain (especially after exercising outside, which is common for this age group) |
|  <p>Specific to Pregnant Women</p> | <ul style="list-style-type: none"> • Heat rashes in body areas that rub against each other • Muscle cramping in stomach | <ul style="list-style-type: none"> • Very high body temperature • Extreme nausea • Early contractions • Swelling of body parts • Severe muscle cramping |

ACT IMMEDIATELY to protect

Once symptoms are well understood in the community, if severe or dangerous symptoms are observed – whether at home, school, preschool or any other institution – it is important for caregivers and front-line workers to **immediately triage and provide first aid treatment to the individuals and assist them in going to the health facility.**

Table 2 outlines the immediate support that front-line workers can provide to infants, children and pregnant women. Front-line workers and caregivers should aim to stock or always carry with them the following during extreme heat periods:

- Water bottle with drinking water: to rehydrate people experiencing heat stress

- Small towels: to use to cool down overheated bodies
- ORS packets: to mix into water for overheated/dehydrated individuals
- *Optional:* Thermometer: to check temperature outside as well as inside houses, school rooms, ECD centre rooms, and other spaces

Important Note: For treating milder symptoms of heat stress in infants under 6 months of age, it is important for the front-line worker to emphasize the practice of exclusive breastfeeding. A 2022 systematic review of how hot weather impacts infant feeding practices in low- and middle-income countries found that “even under hot conditions, exclusively breastfed infants maintained normal hydration levels without concentrating urine.”⁷⁰



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Table 2 Recommendations for providing first aid to individuals with heat stress symptoms⁷¹
 High severity and urgency

| | |
|---|--|
| <p>Step 0 Cool and rush to a health facility if severe</p> | <p>Take to a health facility:</p> <ul style="list-style-type: none"> • If a child or infant is confused or not responding; is having seizure; has a high body temperature, especially with no sweat; has rapid heartbeat or breathing; or has a sunken forehead • If a pregnant woman is confused or not responding; is having seizures; has a high body temperature, especially with no sweat; has rapid heartbeat or breathing; is fainting; or has early contractions or intense cramping <p>It is important to cool the body immediately if they are experiencing severe symptoms of HRI.</p> <p>For this, have the infant, child or woman sit or lie down in a cool, shaded area with good ventilation. Close curtains to create more shade. If there is a fan or air conditioner in the house, turn it on. Apply wet towels or cloth to the skin at head, neck, armpits and groin. If available, apply cold water and ice over the body.</p> <p>Infants and children: have caregivers remove outer layers of clothing.</p> <p>Pregnant women: have them remove excess layers of clothing in a private area (if possible). Have them sleep on their left side or leaning to the left.</p> <p>If unconscious or vomiting, lay the person on their side until transport arrives.⁷²</p> <p>If no severe symptoms, continue to step 1.</p> |
| <p>Step 1 Reduce temperature</p> | <p>Move the person into a cool, shaded area with good ventilation. Close curtains to create more shade. If there is a fan or air conditioner in the house, turn it on.</p> <p>Infants and children: Apply wet towels or cool water to the body, particularly at head, neck, armpits and groin. Keep changing the cloths or dipping them in cool water every few minutes to provide cool water for the body. If the child is young, ask the caregiver what symptoms they have noticed.</p> <p>Do not immerse infants and young children into very cold water.</p> <p>Do not point fan at the face, especially with infants.</p> <p>If the nose is bleeding, tilt the head slightly forward and pinch the soft part of the nose for 10 minutes. Catch blood in napkin or cloth.</p> <p>Pregnant women: Apply wet towels or cool water to the body, particularly at head, neck, armpits and groin. Keep changing the cloths or dipping them in cool water every few minutes to provide cool water for the body. Ask about heat rashes and any contractions they may have experienced. Check for swelling at hands, wrists, ankles, and feet.</p> <p>Hands and feet can be put into containers of cool water to help improve bodily comfort.^{73,74}</p> <p>Older children and adults can be immersed into cool (but NOT ice cold) water if available or put under a cold shower.</p> <p>Use a misting spray to spray cool water onto the body and dry it off with a fan running at the same time. Place ice or a wet towel on the neck, armpits or groin with the fan running as well. Help fan the body manually if no electric fan is present.</p> <p>Do not give paracetamol without advice of health provider.⁷⁵</p> |
| <p>Step 2 Rehydrate</p> | <p>Infants under 6 months: Breastfeed to rehydrate the infant. Encourage mother to drink more water, especially if breastfeeding.</p> <p>Older infants and children: Supply water or support the family in sourcing water from the nearest safe water source (e.g., well, borehole, tap). Ensure that the infant or child is given water in small amounts to help them become used to it.</p> <p>If the child has sweated a lot or is sweating a lot, have the caregiver add some ORS to the water for the child. Pay special attention to the directions on the packet. If there are no directions, use the following guidance:</p> <ul style="list-style-type: none"> • A child under the age of 2 years needs at least 1/4 to 1/2 of a large (250-millilitre) cup of the ORS drink • A child aged 2 years or older needs at least 1/2 to 1 large (250-millilitre) cup of the ORS drink <p>Pregnant women: Supply water or support the family in sourcing water from the nearest safe water source. Add ORS to water if excessively sweating.</p> <p>If no premade ORS is available:</p> <ul style="list-style-type: none"> • Give the child or woman a drink made with 6 level teaspoons of sugar and 1/2 level teaspoon of salt dissolved in 1 litre of clean water. <p>Have older children and pregnant women drink 100 millilitres of ORS every 5 minutes until they seem better.⁷⁶</p> |
| <p>Step 3 Remind</p> | <p>Finish providing first aid by sharing a list of recommendations on how to prevent future heat stress.</p> <p>Go through the list of symptoms of heat stress (found in Table 1) as well as recommendations for how to stay safe and protect pregnant women and children right before and during extreme heat periods (found in 'BE AWARE of heat stress and protect yourself' subsection above).</p> |

TAKE to a health facility

If the patient is presenting severe symptoms, as listed in Table 1, the front-line worker should either call for ambulatory services or arrange for other transport of the patient to the health facility immediately. These are the symptoms most commonly

associated with heat stroke and the most severe HRIs, which can lead to serious and long-term consequences such as organ and nerve dysfunction and damage, muscle breakdown, abnormal fetal development, and issues during delivery.



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Treat in health facilities: Diagnosis and case management flow for pregnant women, infants and children

Diagnosing HRIs in clinical settings





Table 3 captures the six main types of HRIs that present in infant, child and pregnant populations, along with dehydration, which is commonly present with HRI. When providing recommendations, it is

important to also discuss with the patient: a) their lifestyle practices and social determinants that may expose them to heat more than the general population; and b) any medications that may worsen the symptoms of HRIs (refer to Table 4 for more information).



Table 3 Signs and symptoms of heat-related illnesses in infants, children, adolescents and pregnant populations

 High severity and urgency

| Target Populations | Heat Stroke | Heat Exhaustion | Heat Syncope | Heat Cramps | Heat Edema | Heat Rashes | Dehydration** |
|--|--|--|--|--|---|---|--|
| All Populations  | <ul style="list-style-type: none"> • Altered mental state (e.g., inappropriate behaviour, seizures, delirium, slurred speech, extreme lethargy, coma/loss of consciousness) • Very high core body temperature (40°C/104°F) • Associated symptoms include: <ul style="list-style-type: none"> • Nausea • Rapid heartbeat/breathing • Hot and dry or damp skin • Sweating may or may not be present | <ul style="list-style-type: none"> • No altered mental state • High core body temperature (under 40°C/104°F) • Increased thirst • Heavy sweating • Headache • Cool and/or damp skin • Weakness and tiredness • Muscle cramps • Nausea or vomiting | <ul style="list-style-type: none"> • Brief loss of consciousness, usually in person standing for a prolonged period or rapidly changing positions in a warm environment | <ul style="list-style-type: none"> • Painful and involuntary contractions of skeletal muscle • Flushed and/or moist skin | <ul style="list-style-type: none"> • Swelling of hands, feet or other dependent areas | <ul style="list-style-type: none"> • Tiny bumps on skin, usually in chest or upper back • Could result in tiny blisters | <ul style="list-style-type: none"> • Dry mouth and tongue • Sticky lips/mouth • Drowsy or sleepy • Little urine • Dark urine • Dizziness • Sunken eyes |
| Specific to Infants and Children under 4 years  | <ul style="list-style-type: none"> • Very irritable (unable to express specific symptoms) • May present symptoms of dehydration as well | <ul style="list-style-type: none"> • Very irritable (unable to express specific symptoms) | | <ul style="list-style-type: none"> • Very irritable (unable to express specific symptoms) • Mild/slightly high core body temperature may be present (less than 39.5°C/102.5°F) | | <ul style="list-style-type: none"> • Can occur in diapered area or if baby is overclothed/overdressed | <ul style="list-style-type: none"> • Sunken soft spot (fontanelle) on baby's head and cheeks • No tears when crying • Decreased urine output or dark urine • Irritable (unable to express specific symptoms) |
| Specific to Older Children and Adolescents  | <ul style="list-style-type: none"> • May be associated with exertion, e.g., sports | <ul style="list-style-type: none"> • Muscle cramps (may be verbally expressed) • Nausea (may be verbally expressed) | | | | | |
| Specific to Pregnant Women  | <ul style="list-style-type: none"> • Very high core body temperature (above 39°C/102°F)* • Symptoms of severe dehydration such as labour contractions (Braxton Hicks) may present | <ul style="list-style-type: none"> • Increase in core body temperature (under 39°C/102°F) | | <ul style="list-style-type: none"> • Involuntary contractions may affect calves, arms and stomach area (most common) | <ul style="list-style-type: none"> • Swelling most often seen around lower legs and feet | <ul style="list-style-type: none"> • Tiny bumps on the skin, in particular in the crease between and beneath the breasts, crease where bulge of lower abdomen rubs against the top of pubic area, on back, inner thighs, armpits, and other creasing areas | <ul style="list-style-type: none"> • Inadequate breastmilk production • False labour (Braxton-Hicks) contractions |

Source: Adapted from various sources.⁷⁷

* While literature is still being generated to form consensus, the current convention is to presume that pregnant women are at higher risk at a lower core body temperature due to the potential effect that it has on the developing fetus. This also reflects guidance published by the Centers for Disease Control and Prevention (CDC).

** According to a publication in American Family Physician, if children present symptoms of dehydration, commercial electrolyte solutions or local/home-based rehydration solutions should be administered using only clear liquids.⁷⁸ Infants 6 months and under should be exclusively breastfed.

Case management flow for diagnosing and treating HRIs in vulnerable populations

When vulnerable populations are admitted as patients to a health facility, it is important to ensure that they are assessed immediately for any HRIs, especially if they mention or exhibit any of the symptoms listed in Table 3. To properly diagnose patients, clinicians and other health facility staff need to become familiar with the case management flow that is recommended for infants, children and pregnant women admitted to their facilities with symptoms of heat stress.

The flow charts (see Figures 6 and 7) demonstrate how these populations can be triaged and treated at the health facility based on a hierarchy of symptom

Management of HRIs in health facilities

In 2022, Dr. Cecilia Sorensen and Dr. Jeremy Hess published an evidence-based journal article on the treatment and prevention of HRIs in clinical settings, targeted towards addressing symptoms of heat stress in general adult populations. The full article and the case management flow chart can be found [here](#).

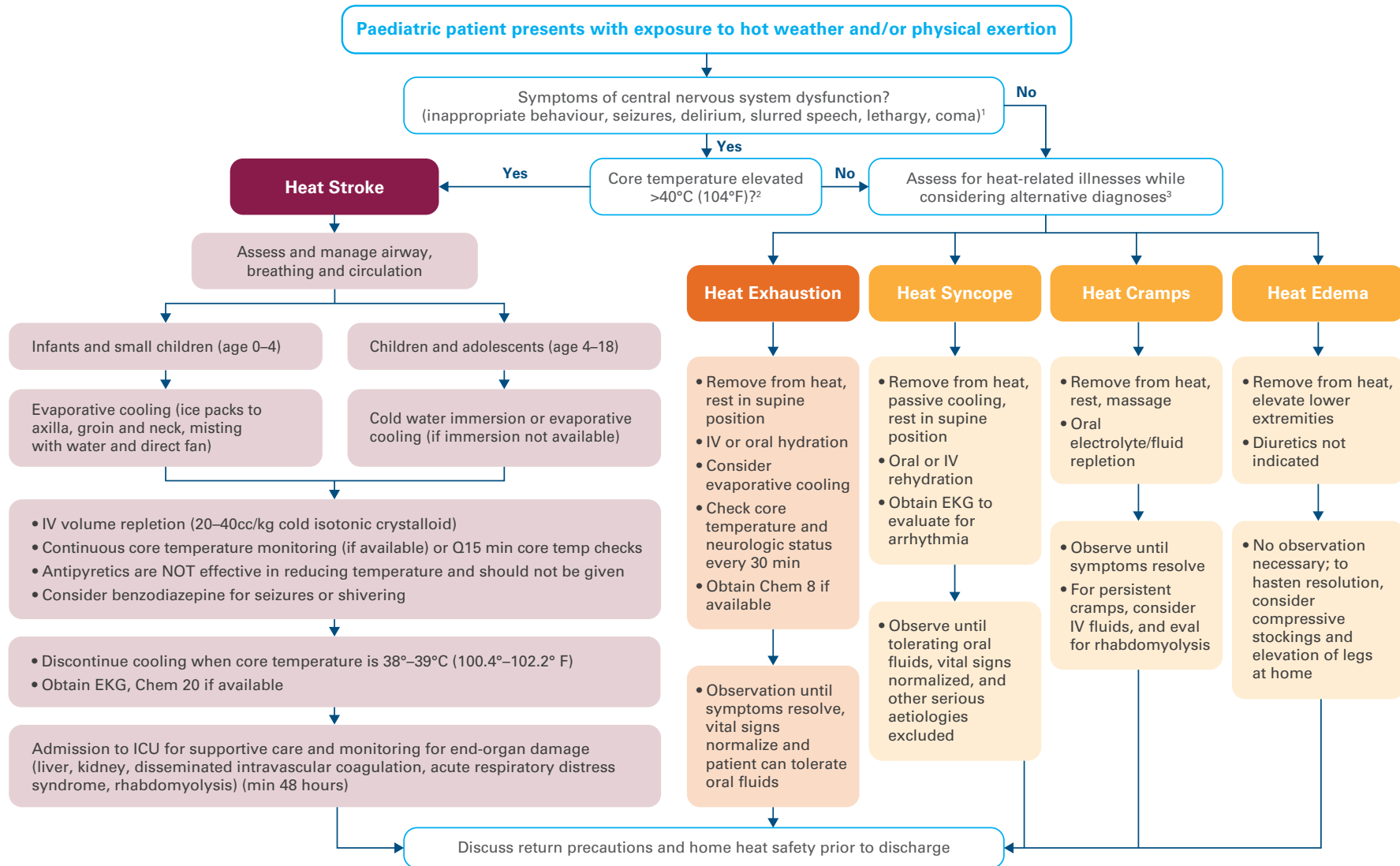
Based on this understanding, the case management flow charts for paediatric and pregnant populations were developed.

assessment. Each figure is followed by footnotes relevant to better understanding and interpreting the instructions in the flow charts, as well as a checklist for clinicians to go through prior to discharging the patient.



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Figure 6 Case management of heat-related illnesses in paediatric populations



1. Symptoms of central nervous system dysfunction may be subtle and can manifest as impaired judgment or inappropriate behaviour. However, children commonly present with more significant neurologic symptoms such as seizures, delirium, hallucinations, balance issues, slurred speech or coma.
 2. Keep in mind that some cooling may have occurred during transportation and the temperature may be less than 40°C at the time of presentation. If in doubt, treat for heat stroke.
 3. Assess for differential diagnosis if the patient presents with altered consciousness and/or elevated core temperature, such as severe traumatic brain injury (often accompanied by hyperthermia), infectious diseases (sepsis), toxic overdose, meningitis/encephalitis, serotonin syndrome, neuroleptic malignant syndrome, thyroid storm, etc.

Once the infant, child or adolescent is stabilized and/or provided the necessary treatment, the health provider is recommended to go through the following checklist before discharging and complement it with key risk communication messaging for the caregiver (provided in Section 3, under 'BE AWARE of heat stress and protect yourself'). Specific medical instructions are included below.

Health provider checklist for discharge of infants, children and adolescents

- Discuss comorbidities and social factors with caregiver that may increase child's risk of HRI
- Review recommendations to PREVENT future HRI and schedule any follow-ups during cooler parts of the day, week or month (can use list of messages in Section 3, under 'BE AWARE of heat stress and protect yourself')
- Review signs and symptoms of HRI in children (see Table 1) and 'B.E.A.T. the Heat' risk communication framework with caregiver to facilitate treatment of mild symptoms at home; advise caregiver to return to health facility if they observe any severe symptoms
- Ensure patient has a cool environment to return home to OR access to a nearby cooling facility; if not, advise on how to stay cool using fans, towels, baths, sprays, curtains, etc.

Example of paediatric case management adapted to the country level

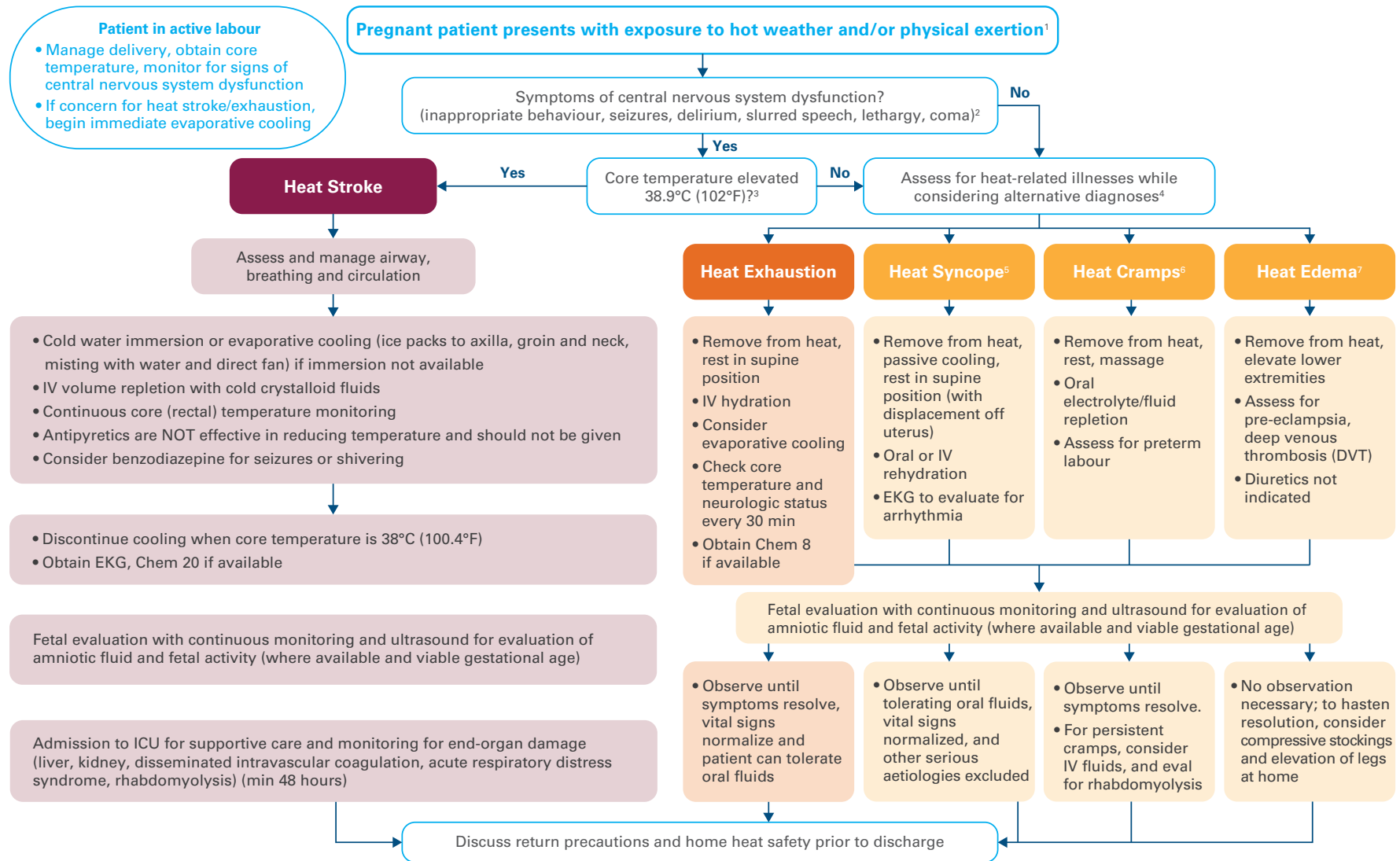
The Government of India's 2021 'National Action Plan on Heat Related Illnesses' is intended to be used by government and private health care facilities, health departments, and policymakers tasked with strengthening health facilities and emergency response. Within it is an example of a clinical workflow for managing heat stroke in children, complemented by recommendations for managing heat stress in paediatric populations. See the [action plan](#) to learn more.

- Ensure family is being visited by a community health worker and has their contact information (if relevant to the community)
- Write prescription with advice for caregiver and other family members to keep handy

Specific recommendations for caregivers

DO NOT give infants and children paracetamol or other antipyretics at home if they are showing symptoms of heat stress again – implement the 'B.E.A.T the Heat' risk communication framework or bring to health facility if severe.

Figure 7 Case management of heat-related illnesses in pregnant populations



1. Pregnant patients may present with myriad symptoms, including contractions/pelvic cramping or high body temperature. Evaluate for active labour.
 2. Symptoms of central nervous system dysfunction may be subtle and can manifest as impaired judgment or inappropriate behaviour, or more neurologic symptoms may be present, such as seizures, delirium, hallucinations, balance issues, slurred speech or coma.
 3. Keep in mind that some cooling may have occurred during transportation and the temperature may be less than 38.9°C at the time of presentation. If in doubt, treat for heat stroke.
 4. Assess for differential diagnosis if the patient presents with altered consciousness and/or elevated core temperature, such as severe traumatic brain injury (often accompanied by hyperthermia), infectious diseases (sepsis), toxic overdose, meningitis/encephalitis, serotonin syndrome, neuroleptic malignant syndrome, thyroid storm, etc.
 5. Heat Syncope: Alternative life-threatening diagnoses to consider include: pulmonary embolism, aortic dissection, coronary dissection, amniotic fluid embolism, uterine rupture, placental abruption, and ruptured ectopic.
 6. Heat Cramps: Alternative life-threatening diagnoses to consider include: HELLP syndrome, uterine rupture, ruptured ectopic, and placental abruption.
 7. Heat Edema: Alternative diagnoses to consider include: pre-eclampsia, deep venous thrombosis (DVT), and Mirror Syndrome.

As with paediatric populations, clinicians can go through the following checklist with pregnant patients and their caregivers to help lower the risk of subsequent HRIs.

Health provider checklist for discharge of pregnant women

- Discuss comorbidities and social factors with caregiver that may increase the pregnant woman's risk of HRI
- Review recommendations to PREVENT future HRI and schedule any follow-ups during cooler parts of the day, week or month (can use list of messages in Section 3, under 'BE AWARE of heat stress and protect yourself')
- Review signs and symptoms and the 'B.E.A.T. the Heat' risk communication framework with the pregnant woman; emphasize the importance of immediately cooling the body and maintaining access to water
- Ensure patient has a cool environment to return home to OR access to a nearby cooling facility; if not, advise on how to stay cool using feet immersion, fans, towels, baths, sprays, curtains, etc.
- Ensure family is being visited by a community health worker and has their contact information (if relevant to the community)
- Recommend making follow-ups and prenatal visits in the cooler parts of the day or week
- Write a prescription with advice for woman and family members to keep handy

Specific recommendations for pregnant patients

- Sleep on left side to reduce the risk of swelling
- If starting to feel overheated, can place hands or feet in cool water for 20 minutes or so for relief, or use wet towels with a fan on
- It is OKAY to exercise at light and moderate intensity, as long as not feeling uncomfortable and hydrating properly during

Medications, complications and comorbidities

When issuing a treatment, clinicians should note what medications and existing vulnerabilities can predispose individuals towards a greater risk of experiencing heat stress, or cause complications due to it.

Medication: Patients should be made aware of the effects of medications on body heat and dehydration. Patients should be encouraged to remain hydrated and to take all necessary breaks from heat exposure during their use. This will enable the patient to be more aware of what is contributing to their diagnosis and help them practice self-care outside of the health care facility.

Table 4 has a summary of medical drugs and agents to be aware of, provided by the Oregon Health Authority in the United States. It can be used as a handy aide by doctors and pharmacists.



Table 4 Mechanisms for medication increasing the risk of heat-related illnesses

| Effect | Medication/Agent |
|---|--|
| Reduced vasodilation | Beta-blockers |
| Decreased sweating | Anticholinergics, e.g., tricyclic antidepressants and benztropine, beta-blockers, antihistamines, phenothiazines |
| Increased heat production | Antipsychotic drugs, e.g., risperidone and olanzapine; stimulants, e.g., amphetamine, cocaine, caffeine |
| Decreased thirst | Butyrophenones, e.g., haloperidol and droperidol; angiotensin-converting enzyme (ACE) inhibitors |
| Dehydration ⁷⁹ | Diuretics, caffeine, alcohol |
| Aggravation of heat illness by worsening hypotension in vulnerable patients | Vasodilators, e.g., nitrates, calcium channel blockers, other antihypertensives |
| Increased toxicity for drugs with a narrow therapeutic index in dehydration | Digoxin, lithium, warfarin |

Adapted from Oregon Health Authority.⁸⁰

Comorbidities and health emergencies causing excessive mortality from heat stress

Many individuals are already more susceptible to extreme heat because they have pre-existing medical and health conditions that exacerbate the effects of heat stress; this could be due to infections or diseases triggering biological reactions that weaken the body’s response to heat stress. Additionally, individuals living in areas affected by health emergencies can also face higher risk from heatwaves or extreme heat periods, as the diversion of resources to another emergency leaves fewer staff, rooms and materials available to treat heat stress.

Protecting populations from extreme heat during the COVID-19 pandemic

Concurrent pandemics and disease outbreaks are known to complicate protocols traditionally useful for addressing heatwaves. G. S. Martinez et al. provide preliminary review on how to mitigate heat stress in the midst of concurrent outbreaks like the COVID-19 pandemic, including implementing strict personal protective protocols in shared cooling spaces, creating timed slots for outdoor activities, and other options that require testing and validation. [Read more here.](#)

For instance, researchers have found “significantly enhanced heat-related mortality during the first four heatwave episodes of 2020” in Portugal, at the same time that the COVID-19 pandemic was spreading along with a strain of influenza.⁸¹

Therefore, it is important for facilities to:
 a) have contingency plans in place to treat heat stress in vulnerable populations during any disease outbreaks; and b) be aware of comorbidities that might complicate the

treatment of and recovery from heat stress. Table 5 captures chronic illnesses and impairments that can leave individuals at higher risk of experiencing HRIs.

Table 5 Medical conditions that put people at increased risk during periods of extreme heat

| Condition | Types |
|-------------------------------------|--|
| Chronic illnesses | Heart disease, high blood pressure, diabetes, cancer, kidney disease, alcohol and other substance use, mental illness, respiratory illnesses (e.g., asthma) |
| Conditions that impair sweating | Heart disease, dehydration, extremes of age, skin disorders (e.g., sunburn, prickly heat, excessive scarring and burns), congenital impairment of sweating, cystic fibrosis, Parkinson’s disease, quadriplegia, scleroderma, people taking medications with anticholinergic effects, acute illness |
| Impaired activities of daily living | Poor mobility, cognitive impairment |

Source: Oregon Health Authority.⁸²

In addition, lifestyles that are solitary or socially isolated can add to one’s vulnerability, as can low socio-economic status, being employed in jobs requiring outdoor exposure – such as farming and construction work – and indoor environments without significant ventilation or mechanical cooling.

Illnesses with similar symptoms and pathologies

Because most HRI symptoms are shared by other illnesses – such as headaches, high body temperatures and dizziness – there is a risk of misdiagnosing such illnesses as HRIs and vice versa. For example, sepsis, a life-threatening infection that can lead to tissue damage and organ failure, has overlapping

symptoms and shared pathophysiological traits with heat stress. Symptoms of sepsis include high temperature, confusion and sleepiness, and shortness of breath.⁸³ In pregnant women, pre-eclampsia can produce symptoms such as severe headaches, vomiting and sudden swelling of hands and feet.⁸⁴ Maternal sepsis, which can also become a life-threatening condition, produces symptoms such as fevers, rapid heartbeat, dizziness, and fatigue⁸⁵ – all common to heat exhaustion.

Therefore, it is important for health providers to carefully consider the manifesting symptoms, differences in the combination of symptoms, social and biological factors, as well as medical histories when diagnosing patients who are presenting HRI symptoms.

Invest in preparedness: Preparedness is key to protecting vulnerable populations from heat stress

The 'B.E.A.T. the Heat' risk communication framework and patient case management in health facilities outlined in Sections 3 and 4 provide the front-line response for prevention, diagnosis, care and treatment of heat stress with a focus on vulnerable populations. However, these models are only effective with the right investments in social and behaviour change (SBC), technical skills and critical resources.

Multilevel, multisectoral, and multi-stakeholder preparedness and response planning is therefore key to support the front-line response needed to protect vulnerable populations. National and local governments must provide the necessary leadership to protect populations from heat stress. The response requires

multisectoral engagement between health, education, transport and other sectors. Additionally, private sector and civil society engagement is key to ensure a 'whole of society' ownership, and to foster collective preparedness and response to support vulnerable populations.

Designing a communication campaign, step by step

UNICEF and CommonThread collaborated to design a programme guidance on how to approach and implement a holistic and data-driven behaviour change campaign. The guidance introduces each of the **key components** of an effective campaign, how to design **multichannel communication plans**, and more.

Planning and implementing a risk communication campaign

For an effective risk communication campaign, it is useful to consider an SBC approach. SBC seeks to apply tactics from marketing, social and community mobilization, mass media, entertainment, advocacy, interpersonal communication, social media and other communication approaches to support positive social and individual change.

The 'B.E.A.T. the Heat' risk communication and first aid response (Section 3) provides a way of organizing the substantive elements within a communication campaign. This framework and relevant messaging (found under 'BE AWARE of heat stress and protect yourself' in Section 3) would need to be contextualized based on local objectives, audience, language and data, and resources prioritized for the purpose of protecting children from heat stress. It is important for the campaign to link messaging and skilling with regular

use of early warning systems and daily weather forecasts, in order to familiarize communities with the resources and practices.

A primary health care approach requires community engagement dimensions where community actors and structures work together to meaningfully participate and leverage their existing resources to foster two-way dialogue, provide contextualized socio-cultural support, mobilize resources, and implement local-level action and solutions. Additionally, a 'whole of society' approach, i.e., multi-stakeholder and multisectoral, is important to expand the outreach for protecting children and other vulnerable populations from heat stress. For this, it is important to engage health, education and other line ministries, private sector partners, civil society partners, young people and the media.

The risk communication campaign would need to be initiated in the weeks or months prior to anticipated extreme heat periods.



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Preparing schools and ECD centres **Adapting policies and infrastructure**

Orienting teachers and care providers

Teachers and ECD caregivers should be skilled on the 'B.E.A.T the Heat' risk communication framework and should **effectively differentiate between mild and severe symptoms of heat stress in infants, children and pregnant women, and know what immediate actions to take in each case.** This can prevent overburdening emergency care departments with mild cases that are manageable, allowing for quick treatment of severe ones before long-term damage sets in.

Managing extreme heat in schools in Arizona, United States

In 2021, The Arizona Department of Health Services developed guidance for schools on how they can better protect students during extreme heat periods and the transition period before. Examples include what can be done by students and administrators, as well as what can be adapted infrastructurally. The guidance can be [found here](#).

The following recommendations can help critical infrastructure such as schools and ECD centres effectively adapt to extreme heat:

- Establishing a first-aid station including towels, water bottles, ORS packets and thermometers
- Shifting play time to hours when the heat is lower (e.g., in the later afternoon or earlier in the morning)
- Providing shade and cooling appliances in key areas (e.g., a tent cover over or trees around a playground, curtains for classroom windows, or cooling fans in classrooms)
- Instituting a looser school uniform policy for the spring and summer seasons (e.g., no ties or jackets, cotton clothing, breathable shoes, allowing hats)
- More water stations provided on school grounds, and between-class breaks to allow for hydration (e.g., offering a hydration break every 30 minutes)
- Stocking ORS packets and sunscreen in every class and administrative room on the school grounds
- Communicating with parents and students on the dangers of heat stress (e.g., conducting an awareness session at the next parent-teacher association meeting)
- Posting communication material in classrooms highlighting best practices and heat-stress symptoms, and ensuring that students are able to provide peer-to-peer support

Preparing health care facilities

Training health care workers

Prior to predictable months of extreme heat, facility staff – clinicians, nurses, community health workers and midwives – can be trained to prevent, diagnose and treat HRIs, especially in vulnerable populations. In particular, this includes training health facility staff on case management flow charts for infants, children and pregnant women.

Health departments can also explore how to integrate management of HRIs in children under 5 years into the Integrated Management of Childhood Illness framework in order to institutionalize the work.

Community health workers, private sector health care providers and midwives require a full understanding of the particular vulnerabilities of pregnant women and young children and how to 'B.E.A.T. the Heat'. In addition to the training of health care workers, specific provisions must be made to ensure that they are understanding the risk communication framework to protect vulnerable populations from heat stress.

Facilities need to be accessible and comfortable during extreme heat periods

According to a [2022 review](#), "[h]igh ambient temperatures may also undermine healthcare seeking behaviors during pregnancy" as they can require pregnant women to wait in long queues in hot spaces to receive care.

Facilities can make temporary adaptations to services and infrastructures that reduce these risks during extreme heat periods. [A study](#) of the health effects of the 2010 heatwaves in Ahmedabad, India, found that relocating the maternity ward to lower floors had a protective effect on newborn health.

When considering how to protect and support staff comfort, [this checklist](#) on the Global Heat Health Information Network can be useful for ensuring that appropriate strategies are being implemented.

Facilities will need to also prepare for higher admission rates to emergency wards during extreme heat periods and will have to adapt spaces accordingly.



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The following steps can be taken in the months ahead of predictably hot periods as well as in the weeks prior to a forecasted extreme heat period.

In the 1–2 months before a heatwave or extreme heat period:

- Designate a focal point to be responsible for monitoring the extreme heat and heatwave forecast, keeping staff informed, and assessing the facility's readiness for response.
- Develop checklists for facility preparation ahead of extreme heat periods, including case management for diagnostic and treatment services, appliances or alternative arrangements for cooling, necessary supplies and medications, shaded areas, first-aid stations, adapted personal protective equipment for staff, and capacity building.
- Coordinate with front-line workers to ensure that key risk communication messaging is up to date and orientations on the 'B.E.A.T the Heat' risk communication framework are provided.
- Consider mobile health units and telemedicine phone lines that can collaborate with front-line workers to provide urgent services to individuals who are exhibiting severe symptoms and are unable to make it to the facility in time.
- Make necessary adjustments to the health facility to protect vulnerable populations from heat stress. This may involve relocating maternity and neonatal wards, organizing shaded waiting areas if the facility does not have any already, and providing regularly filled water tanks and cups.
- Arrange team meetings prior to periods of extreme heat to discuss the facility's preparations, including adjusted staffing

plans to accommodate for increased emergency visits, a review of the triage policy, the case management flow charts for paediatric, pregnant and elderly populations, and how to document cases within existing data management systems. Adapt patient monitoring forms and electronic systems to capture relevant information.

- Ensure that the health facility is at a comfortable temperature for patients and staff, and conduct a **WASH FIT** assessment to find any gaps in infrastructure, water supply, sanitation and service needs.
- Arrange maintenance for cooling systems, vaccine fridges, windows and curtains prior to the spring and summer seasons, or prior to when extreme heat is generally predicted to occur.
- Develop a business continuity and/or emergency contingency plan in case the power supply fails or there is a resource/capacity shortage.

Temperatures within health facilities

Different hospital rooms may require different optimal temperatures to make the patient feel as comfortable as possible.

For operating rooms, clean workrooms and endoscopy suites, the temperature range should be 20°–23°C (68°–73°F).

For rooms that require greater degrees of patient comfort, such as delivery and patient rooms, 24°C (75°F) may be optimal.

For most other rooms and areas, a temperature range of 21°–24°C (70°–75°F) is ideal.

Temperatures outside of the above ranges, as well as humidity levels outside of 30 per cent to 60 per cent relative humidity within the health care facility may give rise to greater stress and infection. Read more on the [CDC's recommendations here](#).

During a heatwave or extreme heat period:

- Regularly publish daily weather forecasts in public spaces, along with key recommendations for pregnant women and caregivers of infants and children.
- Enact maintenance protocols for water stations and other key areas, and for appliances for maintaining comfortable and heat-sensitive services.
- Conduct weekly updates to all staff and provide regular reminders about the effects of HRIs on vulnerable populations.
- Capture patient data related to HRIs regularly.

After a heatwave or extreme heat period:

- Hold an evaluation meeting with staff to discuss how they dealt with it, what worked well and what needs improvement.
- Regularly interact with community health workers and provide them refresher trainings, optimally ahead of subsequent predicted extreme heat seasons.

Planning Tools

In 2019, the World Health Organization developed a checklist that facilities can adapt and implement ahead of extreme heatwaves and seasons. The checklist, [which can be found here](#), assesses whether the facility has:

- A ready workforce that understands how to diagnose and address HRIs and related complications;
- A risk management strategy;
- Monitoring and assessment frameworks; and
- Infrastructure that dissipates heat and reduces heat generation.

A simplified version of the checklist can be found in the [Ahmedabad Heat Action Plan](#) developed in 2019.



Promote local action: Heat adaptation measures that can be implemented by local or regional governments

Local governments play a significant role in driving a 'whole of society' approach at the local level, which includes engaging the private sector and civil society in triggering necessary adaptation protocols across shared spaces, including health facilities, schools, ECD centres, transportation hubs and other key public places.

Based on the early warning system information or knowledge of predictable timing for extreme heat, local governments can trigger adaptation measures for critical institutions, including initiating capacity building for front-line workers and facility staff, undertaking risk communication campaigns, and establishing water points, short-term tents, and cooling centres in public spaces.

Cooling centres: Evidence and recommendations from the CDC

In 2017, the CDC did an evidence review of the effectiveness of various types of cooling centres used across the world. It found patterns in what made them cost effective and what barriers can potentially limit access by the most vulnerable populations – namely distance, transport, accessibility for the elderly, location and comfort.

Read more about the findings [here](#).

Cooling centres can be spaces within government buildings, libraries, hospital waiting areas, community centres, schools on non-school days, and other buildings that can be accessed quickly by the public through available public transport options. Enclosed and air-conditioned shopping and other pedestrian areas can also be recommended for use for at least a couple of hours a day if households are unable to access cooling otherwise.

Cooling centres ideally provide air conditioning to users. In addition, or alternatively, they can ensure:

- Drinking water stations with ORS packets available
- Front-line workers who can provide first aid
- Cooling fans and/or handheld fans, towels, handheld misters and thermometers
- Shaded areas that also provide ventilation (e.g., curtained windows that also provide cross-ventilation, tented open areas and courtyards)
- A separate area for adolescent girls and women who may want privacy, with access to gender-segregated toilets

Local governments should have focal points and their own emergency or contingency protocols that can be triggered ahead of known extreme heat periods. This could include establishing local meteorological stations that have networks within the community they are serving. They should also be in regular contact with national focal points responsible for disseminating regular weather updates and emergency information via existing warning systems or other communication channels.

In tandem with triggering policy and infrastructural adaptations, use of local offices and meeting halls should also be adapted. It is recommended that meeting times be shifted, and that workers are provided regular access to drinking water stations, resting areas, and information on the 'B.E.A.T. the Heat' risk communication framework.

For longer-term adaptation, local governments can invest in growing more green spaces and tree cover in public areas, increasing water points for the public, and pre-positioning tents, fans, ORS and supplies that can be deployed during periods of extreme heat.



Promote a multisectoral national response plan

Many countries have already developed extreme heat action or response plans outlining multisectoral approaches to mitigating the effects of excess heat on human health. The following recommendations have been taken from existing best practices found in country-level action plans and global guidance.

Effective coordination mechanisms to protect human health from excess heat

A quality multisectoral response plan at the national level should outline clear institutional and individual accountabilities. New roles for emergency/heat officers have emerged in some countries. These individuals will be responsible for coordinating with the mandated agency responsible for instituting climate-sensitive health measures to disseminate early warning system data, trigger communication and adaptation interventions, and monitor the effectiveness of the measures in place for evaluation and updating after the extreme heat period

Resources at the Global Heat Health Information Network

The [Global Heat Health Information Network](#) is an independent, voluntary, and member-driven forum of scientists, practitioners and policy makers focused on improving capacity to protect populations from the avoidable health risks of extreme heat in our changing climate.

Heat-health action plans

The World Health Organization has provided example guidance for drafting heat-health action plans, which now exist in 47 countries, the majority being in Europe. These plans can support governments in both improving the public health response and integrating the response into larger national plans on tackling climate change. The guidance can be [found here](#).

Effective policies for coping with excess heat

A set of regulations and policies can be instituted for implementation during extreme heat periods. These can include shifting resources in health facilities, HRI diagnosis and treatment, adjusting the timing of and regulations around school attendance and uniforms, and protecting outdoor workers during these periods. These policies can also make provisions for more shaded areas, establish temporary cooling centres, and provide greater access to cooling appliances, medical supplies such as ORS packets, and infrastructural adaptations.

Policies should include a strong focus on protecting the health of infants, children, pregnant women and senior citizens. Pregnant women, senior citizens and workers in general should also be granted special provisions if working in extreme heat conditions, such as outside in agricultural fields or in indoor structures prone to high temperatures.

Global examples of workplace protections from heat stress

The National Resources Defense Council has [compiled a list of examples](#) on how various countries are developing and implementing protections and policies for workers exposed to heat.

Early warning and notification systems

A heat alert system constitutes a set of incremental activities based on temperatures or heat advisories issued by the national weather service or other governmental agencies that provide weather forecasts and warnings. This supports a city or municipality in preparing a comprehensive plan that includes preparedness and response activities, which in turn allow for instituting an effective notification system through various communication channels.

The notification system is ideally activated when temperatures or the combination of heat and humidity are at or exceed a threshold that is dangerous for the citizens' health, which is set at different thresholds for different regions and countries. Some countries are going further to explore seasonally adaptive warning systems that adjust thresholds based on monthly indicators.⁸⁶ Early warning and notification systems have overall been found to be effective in providing necessary information to communities and should be prioritized for investment by governments.

Multisectoral warning and notification systems

An example of a multisectoral alert protocol can be found in the [Ahmedabad Heat Action Plan](#) from India, developed in 2019.

Ensuring a primary health care approach to protecting children and other vulnerable populations from heat stress

It is critical for the national multisectoral response plan to include a primary health care approach to managing heat stress. This includes supporting the planning and implementation of a risk communication campaign, preparing schools, ECD centres and health facilities, and providing support to local and regional governments as outlined in Section 4.

Adapting built environments for the long term

Built environment⁸⁷ refers to the part of the physical environment created and constructed by humans. Components of the built environment can be designed to reduce outdoor and indoor temperatures. These are often primary prevention strategies intended to prevent HRI from ever happening. These strategies are particularly advantageous to address the urban heat island, a phenomenon in which metropolitan areas are significantly warmer than surrounding non-urban areas, which is primarily due to the built landscape containing more concrete, dark roofs, transport, and less green space.

What shapes a built environment?

Recent literature has identified the various strategies that can be addressed holistically to keep people cooler. You can learn more from the following:

[Reducing the health effects of hot weather and heat extremes: from personal cooling strategies to green cities](#)

[Climate change and extreme heat events: how health systems should prepare](#)

Access to cooling can also include programmes that provide support for cooler environments at home, in addition to community cooling centres. One specific example is known as 'cool roofs', which are currently being implemented in parts of India, and which are painted white or covered with energy-reflecting materials that absorb less heat and can reduce temperatures inside buildings by 2°–5°C when compared with conventional roofing.⁸⁸ Providing green spaces, particularly in neighbourhoods with high levels of poverty, can help avoid increasing morbidities and mortalities due to HRIs.

Zoning/building regulations are city or municipal ordinances that guide or require developers to include infrastructure designed to reduce outdoor and indoor heat in residential or commercial development plans. Upon ratification of these policies, developers would be required to include climate change adaptation building strategies into all plans moving forward. This can also include seeding green canopies into urban plans more frequently and densely, as shaded surfaces have been shown to reduce the local ambient temperatures by 11° to 25°C compared to peak temperatures of unshaded areas.⁸⁹

Monitoring and assessment

A national monitoring framework will be useful for efficiently monitoring HRIs registered at individual health facilities. This can be implemented in collaboration with local or regional governments and the national agency overseeing the heat response. The indicators ideally capture presenting cases of HRIs by age group, gender and whether the patient is pregnant or not, in addition to other general indicators. Efforts are underway to establish global indicators for monitoring heat stress.



Conclusion

Heat stress is associated with a large range of child and maternal health outcomes, which have both short- and long-term implications on the resilience of communities, particularly those already vulnerable. Therefore, we hope that this note will serve as a basis for taking urgent action and protecting infants, children, and pregnant women from the growing climate crisis.

This technical note is a collation of existing evidence and best practices found in various country contexts. As the field continues to evolve and progress, and implementers share feedback on lessons learned, it is expected that this note will be updated and eventually contribute to more formal global guidance on this urgent issue.

Endnotes

- 1 Pörtner, Hans-O., et al., 'Summary for Policymakers', in *Climate Change 2022: Impacts, adaptation and vulnerability – Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by Hans-O. Pörtner et al., Cambridge University Press, Cambridge, UK, and New York, 2022.
- 2 Romanello, Marina, et al., 'The 2022 Report of the *Lancet* Countdown on Health and Climate Change: Health at the mercy of fossil fuels', *Lancet*, vol. 400, no. 10363, 5 November 2022, pp. 1619–1654.
- 3 United Nations Children's Fund, *UNICEF Strategic Plan 2022–2025: Renewed ambition towards 2030*, UNICEF, New York, January 2022.
- 4 United Nations Children's Fund, *Healthy Environments for Healthy Children: Global programme framework*, UNICEF, New York, January 2021.
- 5 Pörtner et al., 'Summary for Policymakers'.
- 6 Institute for Health Metrics and Evaluation, 'High Temperature: Level 3 risk', <www.healthdata.org/results/gbd_summaries/2019/high-temperature-level-3-risk>, accessed 21 March 2023.
- 7 United Nations Children's Fund, *The Coldest Year of the Rest of their Lives: Protecting children from the escalating impacts of heatwaves*, UNICEF, New York, October 2022.
- 8 Ibid.
- 9 *Lancet* Countdown, '1.1.1: Exposure to warming', <www.lancetcountdown.org/data-platform/health-hazards-exposures-and-impacts/1-1-health-and-heat/1-1-1-heat-vulnerability>, accessed 24 April 2023.
- 10 Intergovernmental Panel on Climate Change, 'Glossary of Terms', in *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special report of the Intergovernmental Panel on Climate Change*, edited by Christopher B. Field et al., Cambridge University Press, Cambridge, UK, and New York, 2012.
- 11 World Meteorological Organization, 'Temperatures in Europe Increase More than Twice Global Average', Press release, 2 November 2022, <<https://public.wmo.int/en/media/press-release/temperatures-europe-increase-more-twice-global-average>>, accessed 1 May 2023.
- 12 Roos, Nathalie, et al., 'Maternal and Newborn Health Risks of Climate Change: A call for awareness and global action', *Acta Obstetrica et Gynecologica Scandinavica*, vol. 100, no. 4, April 2001, pp. 566–570.
- 13 Roos et al., 'Maternal and Newborn Health Risks'.
- 14 Kim, Jiyeon, Ajin Lee and Maya Rossin-Slater, 'What to Expect When It Gets Hotter: The impacts of prenatal exposure to extreme heat on maternal health', Working Paper 26384, *NBER Working Paper Series*, National Bureau of Economic Research, Cambridge, Mass., January 2020.
- 15 Konkel, Lindsey, 'Taking the Heat: Potential fetal health effects of hot temperatures', *Environmental Health Perspectives*, vol. 127, no. 10, art. 102002, October 2019.
- 16 Raines, Deborah A., and Danielle B. Cooper, 'Braxton Hicks Contractions', in *StatPearls*, StatPearls Publishing, Treasure Island, Fla., 8 August 2022.
- 17 Samuels, Louisa, et al., 'Physiological Mechanisms of the Impact of Heat During Pregnancy and the Clinical Implications: Review of the evidence from an expert group meeting', *International Journal of Biometeorology*, vol. 66, no. 8, August 2022, pp. 1505–1513.
- 18 Morton, Sarah, Justin Kua and Christopher J. Mullington, 'Epidural Analgesia, Intrapartum Hyperthermia, and Neonatal Brain Injury: A systematic review and meta-analysis', *British Journal of Anaesthesia*, vol. 126, no. 2, February 2021, pp. 500–515.
- 19 Dalugoda, Yohani, et al., 'Effect of Elevated Ambient Temperature on Maternal, Foetal, and Neonatal Outcomes: A scoping review', *International Journal of Environmental Research and Public Health*, vol. 19, no. 3, art. 1771, February 2022.
- 20 'Greater exposure' could signify where rates of preterm birth rose progressively with increasing levels of temperature or with longer durations of heat exposure.
- 21 Chersich, Matthew Francis, et al., 'Associations between High Temperatures in Pregnancy and Risk of Preterm Birth, Low Birth Weight, and Stillbirths: Systematic review and meta-analysis', *BMJ*, vol. 371, no. 8267, art. m3811, 7 November 2020.
- 22 Ibid.

- 23 Mannan, Ishtiaq, et al., 'Vulnerability of Newborns to Environmental Factors: Findings from community based surveillance data in Bangladesh', *International Journal of Environmental Research and Public Health*, vol. 8, no. 8, August 2011, pp. 3437–3452.
- 24 Nakstad, Britt, et al., 'How Climate Change May Threaten Progress in Neonatal Health in the African Region', *Neonatology*, vol. 119, no. 5, October 2022, pp. 644–651.
- 25 Samuels et al., 'Physiological Mechanisms of the Impact of Heat'.
- 26 Kim, Lee and Rossin-Slater, 'What to Expect When It Gets Hotter'.
- 27 Xiong, Tao, et al., 'Association between Ambient Temperature and Hypertensive Disorders in Pregnancy in China', *Nature Communications*, vol. 11, art. 2925, 10 June 2020.
- 28 Part, Chérie, et al., 'Ambient Temperature During Pregnancy and Risk of Maternal Hypertensive Disorders: A time-to-event study in Johannesburg, South Africa', *Environmental Research*, vol. 212, part D, art. 113596, September 2022.
- 29 Bonell, Ana, et al., 'Environmental Heat Stress on Maternal Physiology and Fetal Blood Flow in Pregnant Subsistence Farmers in the Gambia, West Africa: An observational cohort study', *The Lancet Planetary Health*, vol. 6, no. 12, December 2022, pp. 968–976.
- 30 The list of characteristics making infants and children uniquely vulnerable has been sourced from the literature review by Ishimine, Paul, 'Heat Stroke in Children', <www.uptodate.com/contents/heat-stroke-in-children/print>, accessed 21 March 2023.
- 31 Pontzer, Herman, et al., 'Daily Energy Expenditure through the Human Life Course', *Science*, vol. 373, no. 6556, 13 August 2021, pp. 808–812.
- 32 Smith, Caroline J., 'Pediatric Thermoregulation: Considerations in the face of global climate change', *Nutrients*, vol. 11, no. 9, art. 2010, September 2019.
- 33 Bytowski, Jeffrey R., and Deborah L. Squire, 'Heat Illness in Children', *Current Sports Medicine Reports*, vol. 2, no. 6, December 2003, pp. 320–324.
- 34 Naughton, G. A., and J. S. Carlson, 'Reducing the Risk of Heat-Related Decrements to Physical Activity in Young People', *Journal of Science and Medicine in Sport*, vol. 11, no. 1, January 2008, pp. 58–65.
- 35 Ishimine, 'Heat Stroke in Children', abstracts 30, 34 and 35.
- 36 Smith, 'Pediatric Thermoregulation'.
- 37 Cantet, Juan M., Zhantao Yu and Agustin G. Rius, 'Heat Stress-Mediated Activation of Immune-Inflammatory Pathways', *Antibiotics*, vol. 10, no. 11, art. 1285, November 2021.
- 38 Guo, Huiduo, et al., 'Heat Stress Modulates a Placental Immune Response Associated with Alterations in the Development of the Fetal Intestine and Its Innate Immune System in Late Pregnant Mouse', *Frontiers in Physiology*, vol. 13, art. 841149, 4 April 2022.
- 39 Stanberry, Lawrence R., Madeleine C. Thomson and Wilmot James, 'Prioritizing the Needs of Children in a Changing Climate', *PLOS Medicine*, vol. 15, no. 7, art. 1002627, 31 July 2018.
- 40 Bennett, Gregory D., 'Hyperthermia: Malformations to chaperones', *Birth Defects Research Part B: Developmental and reproductive toxicology*, vol. 89, no. 4, August 2010, pp. 279–288.
- 41 Konkel, 'Taking the Heat'.
- 42 Rowland, Thomas, 'Thermoregulation During Exercise in the Heat in Children: Old concepts revisited', *Journal of Applied Physiology*, vol. 105, no. 2, August 2008, pp. 718–724.
- 43 Committee on Sports Medicine and Fitness, 'Climatic Heat Stress and the Exercising Child and Adolescent', *Pediatrics*, vol. 106, no. 1, 1 July 2000, pp. 158–159.
- 44 Ishimine, 'Heat Stroke in Children', abstracts 38 and 39.
- 45 Falk, Bareket, 'Effects of Thermal Stress during Rest and Exercise in the Paediatric Population', *Sports Medicine*, vol. 25, no. 4, April 1998, pp. 221–240.
- 46 Ishimine, 'Heat Stroke in Children', abstract 33.
- 47 Ibid., abstracts 30 and 32.
- 48 Chorley, Joseph, and Adam Saloom, 'Adolescent Running Injuries', in *Encyclopedia of Child and Adolescent Health*, 1st ed., edited by Bonnie Halpern-Felsher, Elsevier, Amsterdam, 2023, pp. 1041–1052.
- 49 Ishimine, 'Heat Stroke in Children', abstracts 31, 32, 36 and 37.
- 50 Chersich et al., 'Associations between High Temperatures in Pregnancy'.

- 51 McElroy, Sara, et al., 'Extreme Heat, Preterm Birth, and Stillbirth: A global analysis across 14 lower-middle income countries', *Environment International*, vol. 158, art. 106902, January 2022.
- 52 Haghighi, Marjan Mosalman, et al., 'Impacts of High Environmental Temperatures on Congenital Anomalies: A systematic review', *International Journal of Environmental Research and Public Health*, vol. 18, no. 9, art. 4910, May 2021.
- 53 Auger, Nathalie, et al., 'Risk of Congenital Heart Defects after Ambient Heat Exposure Early in Pregnancy', *Environmental Health Perspectives*, vol. 125, no. 1, January 2017, pp. 8–14.
- 54 Zhang, Wangjian, et al., 'Projected Changes in Maternal Heat Exposure During Early Pregnancy and the Associated Congenital Heart Defect Burden in the United States', *Journal of the American Heart Association*, vol. 8, no. 3, art. e010995, 5 February 2019.
- 55 Nakstad et al., 'How Climate Change May Threaten Progress'.
- 56 Jhun, Iny, et al., 'Ambient Temperature and Sudden Infant Death Syndrome in the United States', *Epidemiology*, vol. 28, no. 5, September 2017, pp. 728–734.
- 57 Auger, Nathalie, et al., 'Ambient Heat and Sudden Infant Death: A case-crossover study spanning 30 years in Montreal, Canada', *Environmental Health Perspectives*, vol. 123, no. 7, July 2015, pp. 712–716.
- 58 A 2004 study published by the American Academy of Pediatrics found no significant relationship between sudden infant death syndrome and periods of extreme environmental temperatures; data on this correlation is currently sparse. See: Scheers-Masters, Joshua R., Mario Schootman and Bradley T. Thach, 'Heat Stress and Sudden Infant Death Syndrome Incidence: A United States population epidemiologic study', *Pediatrics*, vol. 113, no. 6, June 2004, pp. 586–592.
- 59 Part, Chérie, et al., 'How Do High Ambient Temperatures Affect Infant Feeding Practices? A prospective cohort study of postpartum women in Bobo-Dioulasso, Burkina Faso', *BMJ Open*, vol. 12, no. 10, art. e061297, 5 October 2022.
- 60 Blom, Sylvia, Ariel Ortiz-Bobea and John Hoddinott, 'Heat Exposure and Child Nutrition: Evidence from West Africa', *Journal of Environmental Economics and Management*, vol. 115, art. 102698, September 2022.
- 61 Tusting, Lucy S, et al., 'Environmental Temperature and Growth Faltering in African Children: A cross-sectional study', *The Lancet Planetary Health*, vol. 4, no. 3, March 2020, pp. 116–123.
- 62 Park, R. Jisung, A. Parick Behrer and Joshua Goodman, 'Learning Is Inhibited by Heat Exposure, Both Internationally and within the United States', *Nature Human Behavior*, vol. 5, no. 1, January 2021, pp. 19–27.
- 63 Harvard Kennedy School, 'When the Heat Is On, Student Learning Suffers', 28 May 2018, <www.hks.harvard.edu/announcements/when-heat-student-learning-suffers>, accessed 24 April 2023.
- 64 Isen, Adam, Maya Rossin-Slater and Reed Walker, 'Relationship between Season of Birth, Temperature Exposure, and Later Life Wellbeing', *Proceedings of the National Academy of Sciences of the United States of America*, vol. 114, no. 51, 19 December 2017, pp. 13447–13452.
- 65 Carsley, Alysa, 'Summer Safety: Shade vs direct sunshine', WSAV, 14 June 2022, <www.wsav.com/weather-news/storm-team-3-now/summer-safety-shade-vs-direct-sunshine>, accessed 24 April 2023.
- 66 The latest literature has recommended specific temperature thresholds for fan use for varying demographics; we advise implementers to review it at their discretion. See Jay, Ollie, et al., 'Reducing the Health Effects of Hot Weather and Heat Extremes: From personal cooling strategies to green cities', *Lancet*, vol. 398, no. 10301, 21 August 2021, pp. 709–724.
- 67 National Highway Traffic Safety Administration of the United States Department of Transportation, 'Prevent Hot Car Deaths: Check the back seat', <www.nhtsa.gov/campaign/heatstroke>, accessed 21 March 2023.
- 68 Seattle Children's, 'Heat Exposure and Reactions', 30 December 2022, <www.seattlechildrens.org/conditions/a-z/heat-exposure-and-reactions/>, accessed 24 April 2023.
- 69 Referenced symptoms taken from CDC, WHO and American Pediatric Association.
- 70 Edney, Jessica M., et al., 'A Systematic Review of Hot Weather Impacts on Infant Feeding Practices in Low- and Middle-Income Countries', *Frontiers in Pediatrics*, vol. 10, art. 930348, 6 September 2022.
- 71 World Health Organization Regional Office for Europe, *Public Health Advice on Preventing Health Effects of Heat: New and updated information for different audiences*, WHO/Europe, Copenhagen, 2011.

- 72 *Ibid.*, p. 6.
- 73 Morris, Nathan B., et al., 'Sustainable Solutions to Mitigate Occupational Heat Strain: An umbrella review of physiological effects and global health perspectives', *Environmental Health*, vol. 19, no. 1, art. 95, 4 September 2020.
- 74 Morris, Nathan B., et al., 'A Preliminary Study of the Effect of Dousing and Foot Immersion on Cardiovascular and Thermal Responses to Extreme Heat', *Journal of the American Medical Association*, vol. 322, no. 14, 8 October 2019, pp. 1411–1413.
- 75 *Ibid.*
- 76 Centers for Disease Control and Prevention, 'Rehydration Therapy', 14 November 2022, <www.cdc.gov/cholera/treatment/rehydration-therapy.html>, accessed 21 March 2023.
- 77 Sorensen, Cecilia, and Jeremy Hess, 'Treatment and Prevention of Heat-Related Illness', *New England Journal of Medicine*, vol. 387, no. 15, 13 October 2022, pp. 1404–1413; National Institute for Occupational Safety and Health, 'Heat: Reproductive health', 20 April 2017, <www.cdc.gov/niosh/topics/repro/heat.html>, accessed 24 April 2023.
- 78 Canavan, Amy, and Billy S. Arant, Jr., 'Diagnosis and Management of Dehydration in Children', *American Family Physician*, vol. 80, no. 7, 1 October 2009, pp. 692–696.
- 79 Note: diuretics and alcohol have been found to cause dehydration when ingested in significant amounts, while the fluids in the drinks balance the diuretic effects when taken in moderate amounts; see <www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/expert-answers/cafeinated-drinks/faq-20057965>.
- 80 Oregon Health Authority, 'Fact Sheet: Caring for your vulnerable patients during a heat wave', <<https://sharedsystems.dhsoha.state.or.us/DHSForms/Served/le8817h.pdf>>, accessed 24 April 2023.
- 81 Sousa, Pedro M., et al., 'Heat-Related Mortality Amplified During the COVID-19 Pandemic', *International Journal of Biometeorology*, vol. 66, no. 3, March 2022, pp. 457–468.
- 82 'Fact Sheet'.
- 83 Sepsis Alliance, 'Symptoms', <www.sepsis.org/sepsis-basics/symptoms/>, accessed 24 April 2023.
- 84 National Health Service, 'Overview: Pre-eclampsia', <www.nhs.uk/conditions/pre-eclampsia/>, accessed 24 April 2023.
- 85 University of New Mexico Health System, 'Maternal Sepsis: 5 ways to reduce your risk', 27 May 2022, <<https://unmhealth.org/stories/2022/05/maternal-sepsis-five-ways-reduce-risk.html>>, accessed 24 April 2023.
- 86 Issa, Mahamat Abdelkerim, et al., 'A Heat-Health Watch and Warning System with Extended Season and Evolving Thresholds', *BMC Public Health*, vol. 21, no. 1, art. 1479, 29 July 2021.
- 87 Anderson, Henry, et al., *Climate and Health Intervention Assessment: Evidence on public health interventions to prevent the negative health effects of climate change – Climate and health technical report series*, Climate and Health Program, Centers for Disease Control and Prevention, Atlanta, 2017, p. 32.
- 88 'Cities Must Protect People from Extreme Heat', *Nature*, vol. 595, no. 7867, 14 July 2021, pp. 331–332.
- 89 United States Environmental Protection Agency, 'Using Trees and Vegetation to Reduce Heat Islands', <www.epa.gov/heatislands/using-trees-and-vegetation-reduce-heat-islands>, accessed 24 April 2023.



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