Heatwaves

A GUIDE FOR HEALTH-BASED ACTIONS

PAHO
Pan American Health Organization
World Health Organization
REGIONAL OFFICE FOR THE Americas

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Executive Summary

Following the mega-heatwave that affected Europe in 2003, and the increase in magnitude, duration, and intensity of heatwaves observed worldwide from 2003 to 2018, heat-health risks have gained importance and attention.

Heatwaves can occur throughout the year and are characterized by an unusual increase in temperatures. Sudden increases in temperature do not allow the human body's temperature to acclimatize and trigger the thermoregulatory center response that can overload the cardiovascular system and result in heat-related illness. Mild-to-moderate effects of heatwaves include edema of the lower extremities, syncope or orthostatic hypotension in individuals who take medications with a hypotensive effect, cramps due to loss of fluids and electrolytes, as well as heat exhaustion. Heatstroke is the most severe form of heat-related illness because without timely specialized treatment, it can lead to death.

Heat-related illnesses are compounded by chronic diseases and conditions, especially pulmonary and cardiac conditions and kidney disorders, as well as the use of certain medications. Vulnerability to heat-related illness is also seen in older people and the overweight, people engaging in outdoor physical activities without preventative measures, and the urban poor.

The integration of weather and climate information into unique monitoring and surveillance systems enables comprehensive data analysis, the development of impact-based forecasting as well as the implementation of comprehensive early warning systems. Establishing impact-based forecasting and prediction of heatwaves also requires the recognition by the health sector of environmental determinants as modifying factors in ill-health.

The response to heatwaves requires an integrated approach, including the development of heat action plans with a multi-hazard perspective, early warning system strengthening, threat characterization, activation and deactivation procedure definition, public health capacity reinforcement, institutional coordination, and health service strengthening. This is reflected in the six-step approach: planning and coordination; detection and surveillance; forecasting and prediction; heatwave case management; communication; and intervention strategies. Emphasis is placed on participation and preparedness, above all, at the local level, with the involvement of all sectors.

Introduction

The last few years have seen an increase in the number, magnitude, and duration of heatwaves globally due to climate change. A similar pattern has been observed in the Region of the Americas, especially in the austral summer in the southern hemisphere (from 21 December to 21 February), and the boreal summer in the northern hemisphere (from 21 June to 21 August).

Although the effects of heatwaves are not as evident as those of other natural disasters (e.g., an earthquake or a hurricane), heatwaves can affect human beings, causing disease, death, and damage to agriculture and livestock, and often occur concurrently with power outages, forest fires, and drought. Heatwaves can affect food and water supply, and current and future livelihoods, and disrupt the functioning of society.

Considering the occurrence of more frequent and intense heatwaves in the Region, Member States are recommended to develop heat action plans that include early warning, preparedness, and response actions—not only at the health sector level, but also at the intersectoral level, both nationally and locally.

Building these capacities so that the health sector can adapt to extreme events is in line with the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction, PAHO's Plan of Action for Disaster Risk Reduction 2016-2021, PAHO's Strategy and Plan of Action on Climate Change 2012–2017, and the Paris Agreement under the United Nations Framework Convention on Climate Change.

The purpose of this guide is to raise awareness about the current and future problems of heatwaves, and their potential effect on human health, and to provide tools, information resources, and updated operational messages based on World Health Organization (WHO) and World Meteorological Organization (WMO) guidelines. This guide aims to contribute to the reduction of the mortality, morbidity, and social unrest as a result of a heatwave, through preparedness and response using a multisectoral approach. It provides guidelines on the formulation of heat action plans, strategies, and recommendations for response, and a series of tools and tangible messages.

Heatwaves: A Guide for Health-based Actions is a living document, open to contributions and recommendations from countries and experts, and to new information to replace that contained in the Annexes.

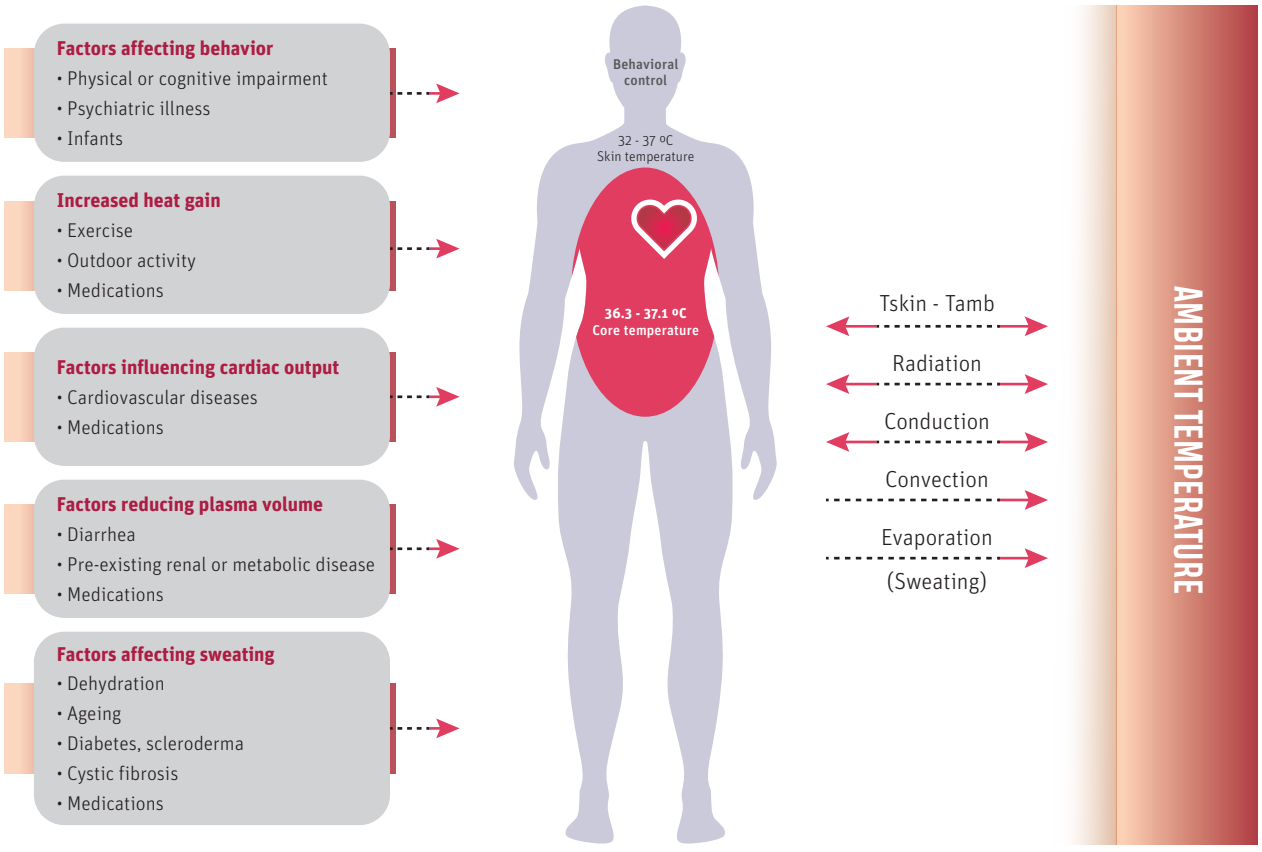
1. Heat and health

1.1 NORMAL PHYSIOLOGICAL RESPONSE

Normal body temperature in humans varies by person and time of day. The average human body temperature is in the range of 36.1 ºC to 37.8 ºC (i.e., an average of 98.7 ºF). The core temperature is regulated by the hypothalamus, which is responsible for regulating heat generation and loss. A person in good health can easily tolerate a moderate increase or decrease in temperatures.

Response to heat depends on the individual and their ability to adapt. The perception of temperature is determined by various individual factors, such as respiratory capacity, level of physical activity and the type of material the clothing worn is made from, as well as environmental factors, such as temperature, humidity, solar radiation, wind speed, and ventilation. The greater the humidity, the stronger the thermal sensation as it reduces the body's capacity to cool adequately. Other risk factors can cause additive or exponential synergistic effects (Figure 1).

Figure 1. Factors affecting human thermoregulation and the risk of heat illness



Source: Matthies F, Bouchama A, Menne B. (in press) Key public health messages to the general public and medical professionals. In: Matthies F, Menne B, editors. Preparedness and response to heat-waves in Europe, from evidence to action. Public health response to extreme weather events. Copenhagen: WHO Regional Office for Europe; forthcoming.

The heat of the human body is lost through: (i) radiation (similar to that of a stove), through which the body loses heat in an ambient temperature under 20 ºC; (ii) convection, by means of water circulation (cold shower) or air (from a fan) in contact with the skin; (iii) conduction, by means of colder objects in direct contact with the skin (sleeping on a cold surface); and (iv) evaporation of sweat or respiration.

1.2 PHYSIOLOGICAL RESPONSE TO EXTREME TEMPERATURES

Individuals may or may not manifest adverse effects while facing extreme temperatures. This depends on their hydration status, the presence of shade, presence of cold or hot air currents, and the level of humidity.

The human physiological response to above-average temperatures includes an increase in the body's temperature, especially if the capacity of the compensation mechanisms is exceeded. The increased temperature detected by the thermoreceptors triggers the response of the thermoregulatory center, which activates peripheral vasodilatation and sweating.

Massive blood flow to the skin through vasodilatation facilitates cooling, but it can overburden the cardiovascular system. Sweating occurs to cool down the human body by interacting with the air (similar to a radiator); however, excessive sweating can cause dehydration through a massive loss of fluids, up to two liters per hour.

The increase of one or two degrees Celsius above the average temperature of the place of residence can generate heat-related health effects, which have been observed at temperatures as low as 27 ºC to 29 ºC. The symptoms caused by heat exposure appear minutes to hours later on the same day. On occasion, effects have been observed up to three days after exposure to heat.

The heatwave that affected Europe in 2003 showed that not only daytime, but also nighttime temperature peaks and humidity variations should be monitored, especially during the sustained high temperatures. In addition to causing discomfort, they increase mortality because they do not allow body temperature to return to basal levels.

2. Populations in condition of vulnerability and risk factors

Heat vulnerability levels depend on exposure and individual sensitivity. Non-climatic risk factors that influence heat sensitivity include socio-economic status, individual characteristics such as physical condition, gender, acclimatization, behavior, body weight and presence of coexisting diseases (e.g., cardiovascular, pulmonary, psychiatric, metabolic or kidney), the use of certain medications (e.g., anticholinergics, antihypertensives, antipsychotics), and alcohol and drug use. In most cases, risk factors compound, leading to a fatal outcome.

People at the extremes of life, newborns, children, pregnant women, older people, people with chronic noncommunicable diseases, people with disabilities, and individuals who engage in outdoor activities such as farm workers, construction workers, or athletes may be in higher condition of vulnerability to the effects of extreme heat.

Figure 2. Factors that influence individual and community-level vulnerability to extreme heat events

Source: Government of Canada. Adapting to extreme heat events: guidelines for assessing health vulnerability [Internet]. Ottawa: Health Canada; 2011 [cited 15 Dec 2020]. Available from: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/climate-change-health/adapting-extreme-heat-events-guidelines-assessing-health-vulnerability-health-canada-2011.html

Heatwave mortality among the poor is more frequent in urban areas that have a heat island effect (*1*),[1] are exacerbated by pollution, and that have unhealthy behaviors and precarious social conditions such as drug use, marginalization, and isolation.

In rural areas of Central American countries (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama) and Mexico (in circumscribed areas), an epidemic of chronic kidney disease of nontraditional etiology (CKDnT) began to be noted in 1997, and is estimated to have killed more than 60,000 agricultural workers (41% < 60 years) between 1997 and 2013 (*2*). Although the etiology of CKDnT has not been defined, it has been associated with pollution, chronic dehydration, heat stress, and long work (*3*).

[1] "Heat islands are urbanized areas that experience higher temperatures than outlying areas. Daytime temperatures in urban areas are about 1–7°F higher than temperatures in outlying areas and nighttime temperatures are about 2-5°F higher." United States Environmental Protection Agency. Heat Island Effect [Internet]. Washington: EPA; (no date) [cited 15 Dec 2020]. Available from: www.epa.gov/heatislands

3. Prevention of the health-related effects of heatwaves

3.1 PREVENTION

The first measure to prevent the health effects of a heatwave is self-care. People should be aware of the risk and avoid prolonged exposure to heat, stay hydrated, wear appropriate clothing and, if necessary, move to cooler places on their own or request help to do so. Special attention should be given to vulnerable individuals, mainly older people, pregnant women, children, and the poor.

If self-care is insufficient and the family or community detects signs and symptoms, they should immediately remove the person from the heat exposure, hydrate them, take them to a shared place that is cool and ventilated, apply physical cooling methods, and help relieve their symptoms. This is where local authorities have a key role in establishing cooling centers with access to safe water, as mentioned in Section 6 Recommendations.

Moderate and severe cases should receive initial pre-hospital care and be transferred as soon as possible to a health care facility or referred to a hospital with greater problem-solving capacity to avoid serious sequelae and death. Care should be provided by staff trained to treat conditions related to heat exposure.

3.2 HEALTH EFFECTS

The initial signs of heat-related heat-health effects include redness of the skin, the presence of papules known as heat rash, muscle cramps due to electrolyte depletion, and edema (or swelling of the lower extremities) due to water retention.

Following prolonged exposure to heat, the skin becomes red and dry, since the perspiration mechanism stops working. At this time, a person loses the capacity to cool off and may rapidly progress from heat exhaustion to heatstroke.

Body heat and mild-to-moderate dehydration can affect the brain and cause confusion or loss of consciousness. More severe dehydration can cause a reduction of the plasma volume and blood clots, which can affect different organs and increase the risk of strokes. Without remediation measures (rest and cooling), body temperature continues to increase and affects the central nervous system, the circulatory system and the kidneys, and can lead to multiple organ failure, such as heatstroke. The health conditions caused by heatwaves are shown in the Annex 1 table.

4. Heat, weather, and climate monitoring

Heat is a complex phenomenon resulting from the interaction of solar radiation, atmospheric temperature, atmospheric humidity, wind speed, and ventilation.

The monitoring of extreme heat events is part of weather and climate monitoring (see Box 1). This monitoring is carried out at the country level by the national meteorological and hydrological services (NMHS) and, on this basis, meteorological forecasts and predictions are issued.

BOX 1. Difference between weather and climate

The difference between weather and climate is a measure of time. Weather is what conditions of the atmosphere are over a short period of time, and climate is how the atmosphere "behaves" over relatively long periods of time.

Source: NASA - What's the difference between weather and climate [Internet]? Washington, DC: NASA; (no date). Available from: www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

The NMHS maintain historical records and the capacity to measure maximum and minimum temperatures and humidity, following the World Meteorological Organization (WMO) guidelines. The operation of monitoring systems is based on forecasting meteorological and climate variables (e.g., maximum and minimum temperatures, humidity, winds).

By the end of 2018, over 90% of the 35 countries in the Region had NMHS in operation or were working with the support of a regional meteorological agency (e.g., such as the Caribbean Meteorological Organization [CMO]).

4.1 DEFINITION OF HEATWAVE

According to WHO and WMO (*4*), there is no precise definition of a heatwave. Some countries define it as a 3–5-day period; others use periods of up to 10–14 days. However, as an operational definition, it is understood as a period of unusually hot weather, dry or humid, that begins and ends abruptly, lasting at least two or three days, with a discernible negative impact on human beings and natural systems. Impact-based definitions are needed for appropriate response.

4.2 HEAT ALERT

A heat alert reports the occurrence of an extreme heat event in the immediate future (in 3–5 days) or the near future (1–3 months) that may have health implications and requires intervention to prevent negative health impacts.

It is important that the alert be issued before the heatwave is established to reduce the mortality associated with a heatwave among individuals in condition of vulnerability.

When impact-based forecasts indicate that the meteorological variables will surpass the established threshold levels, the NMHS informs the health sector, and the response mechanisms are activated in accordance with the health sector's heat action plan.

The health authority, together with the authority responsible for emergency and disaster management, the NMHS, and environmental experts, should agree on the definition of what constitutes a heatwave, with thresholds and alert levels using local health data. This definition will be agreed on during the preparation of the health sector's heat action plan, within the framework of the multihazard plan. These definitions may not be nationally homogenous, and specific vulnerabilities and population groups may need distinct definitions.

5. Global and regional effects of heatwaves and existing capacity in the Region

5.1 GLOBAL AND REGIONAL CONTEXT

Heatwaves are historically known events, which have become a priority since the Chicago heatwave (*5*) in 1995, which caused 696 excess deaths, and the mega-heatwave that affected 16 European countries in the summer of 2003, causing 70,000 excess deaths (*6*).

The year 2018 was the fourth hottest in history, with land and sea surface temperatures in July that exceeded historical records of the last 260 years (*7*). During that year, heatwaves were recorded in Asia, Europe, North America, and Oceania, with over 1,500 deaths. The year 2019 was among the top three hottest since records began, with July recorded as the hottest month in records dating to the mid-to-late-1800s.

The Region of the Americas was also affected by an increase in the frequency, intensity, and duration of heatwaves, with an increase in maximum and minimum temperatures. The availability of historical temperature records depends on the country (e.g., Argentina has kept records since 1961). A literature review shows that heatwaves have affected at least 15 countries in the Region (Argentina, Bolivia [Plurinational State of], Brazil, Canada, Chile, Colombia, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru, the United States of America, and Uruguay). They are estimated to have caused at least 20,507 deaths, of which 17,791 were in the United States of America.

A summary of the situation by country and a table with the estimated number of deaths are presented in Annex 2.

5.2 CAPACITY OF THE HEALTH SECTOR

Countries have national epidemiological information systems, which record mortality and morbidity.

The countries in the Region have a national risk management authority and a health sector disaster preparedness and response authority, both with experience in emergency management that operates within the framework of risk management systems.

5.3 METEOROLOGY

At the country level, atmospheric monitoring is carried out by the NMHS. The operation of the NMHS's monitoring and warning systems includes the prediction of meteorological and climate variables (e.g., maximum and minimum temperatures, humidity, winds).

The NMHS operate at the national level in all of the countries in the Region, with the support of regional entities affiliated with WMO. These agencies can measure temperatures, humidity, and wind levels, and their historic records are aligned with WMO's guidelines.

6. Recommendations

Based on the greater frequency, intensity, and duration of heatwaves across the Western Hemisphere, as reported by the Intergovernmental Panel on Climate Change (IPCC) and the National Oceanic and Atmospheric Administration (NOAA), the creation and strengthening of national capacities to detect and deal with heatwaves in the Region of the Americas is needed.

Against this backdrop, PAHO/WHO developed this guide, which covers actions to strengthen health sector and meteorological capacities based on the formulation of a comprehensive heat action plan that considers impact-based forecasting and prediction, preparedness, and response capacities within the framework of the multihazard plan. Other aspects to be covered in the plan should include: improving the capacities of public and private health care facilities to handle a contingency; considering expanding detection and epidemiological surveillance capacities related to heat-health effects as well as to the worsening of existing health conditions; strengthening prevention and social communication directed toward the national and local authorities and the general public; and reinforcing intersectoral actions.

6.1 PLANNING AND COORDINATION

The objective of planning and coordination is to develop heat action plans based on knowledge of the threat posed by heatwaves, which have government support, define a sectoral and intersectoral operating framework, and allocate resources (*8*).[2]

Therefore, countries should seek to: (i) strengthen the governance of the health sector regarding preparedness and response through the formulation of a health sector's heat action plan that includes characterization of the threat to the vulnerable population, activation procedures (alert), deactivation, roles and functions, and intra- and inter-institutional coordination; and (ii) strengthen the NMHS' meteorological forecasting and prediction capacities complementarily with the health sector.

The heat action plan should be based on an intersectoral strategic risk assessment and on the identification of key players, vulnerable populations, capacities, needs, and resources. The plan can be implemented within an incident management system.

At the national level, the functional adaptation and strengthening of health and meteorological infrastructure and capacities should be considered, including the outfitting of existing infrastructure and the creation of new capacities.

The preparation of the heat plan that covers both health and meteorology should not only include meteorological surveillance, but also human health surveillance of signs and symptoms associated with heat and mortality due to existing conditions and chronic diseases that were exacerbated during the heatwave event. It is important to jointly determine the meteorological thresholds that trigger an alert/warning, as well as the duration of the heatwave based on local information, and response actions.

Priority should be given to actions aimed at strengthening local plans and identifying financial mechanisms to support planning. Moreover, priority should be given to the North-South and South-South sharing of experiences and knowledge related to preparedness and response actions that make it possible to strengthen Member States' capacities.

[2] Guidance on the development of heat health action plans can be found at Matthies F, et al. Heat–health action plans [Internet]. Copenhagen: WHO Regional Office for Europe; 2008 [cited 15 Dec 2020]. Available from: www.euro.who.int/en/publications/abstracts/heathealth-action-plans

6.2 DETECTION AND SURVEILLANCE

Epidemiological surveillance of seasonal morbidity and mortality, and detection of heat-health effects are essential to save lives and quantify the impacts of a heatwave (see Box 2). The need for strengthening national capacities to detect and respond to heatwaves in the Region of the Americas is based on the greater frequency, intensity, and duration of heatwaves across the Western Hemisphere, and the projections of increased occurrences due to climate change issued by the Intergovernmental Panel on Climate Change (IPCC) and the National Oceanic and Atmospheric Administration (NOAA).

BOX 2. Aspects to be considered in relation to detection and surveillance of heat-health effects

- To prevent as much heat-related mortality as possible, define a low threshold; however, the costs would be high and warning fatigue may set in.
- To prevent mortality peaks during very extreme conditions, define only very severe situations as "sufficiently hazardous." Since these conditions are very rare and might occur only once in several years, the total number of lives saved recorded with such a system is smaller, but mitigation costs would also be less.
- Avoid definitions of a heatwave that lasts longer than 3 to 5 days (WHO). This avoids a larger number of cases and makes timely action possible. Although this practice reduces costs and issuing alerts, it may cause an increase in the number of people affected.
- Check the utility of seasonal heatwave surveillance systems. Recent experiences in Europe show that a heatwave can occur in any season.
- Consider using definitions of a heatwave by province and location, as in the case of Canada, where the number of days for defining a heatwave and for issuing the alert varies according to the humidex index (temperature and humidity, and the presence of smog), or in the United States, according to the heat index (temperature and humidity).
- Avoid underestimating the threat of heatwaves. Temperature increases of two degrees Celsius in historically cold countries such as the Nordic countries cause health effects, including an increase in mortality.
- Consider that few deaths are caused directly by a heatstroke; most are due to an exacerbation of preexisting diseases and to short-term mortality displacement or harvesting, that is, death brought forward by a few days or weeks.
- Extend the surveillance of events to individuals with chronic diseases who are at risk during a heatwave. In addition, monitor adverse effects on individuals with chronic diseases who take medications that may have side effects when combined with heat.
- Ensure that heat is included as a contributing cause of death on the death certificates of people with chronic diseases to avoid underreporting.
- Due to the trend of heatwaves increasing in duration, magnitude, and frequency, it is recommended that the authorities reinforce the surveillance of non-traditional chronic kidney disease in areas of the Northern Triangle of Central America.

Source: World Meteorological Organization, World Health Organization. Heatwaves and health: guidance on warning-system development [Internet]. Geneva: World Meteorological Organization and World Health Organization; 2015. Available from: www.who.int/globalchange/publications/WMO_WHO_Heat_Health_Guidance_2015.pdf?ua=1

THE FOLLOWING STEPS ARE RECOMMENDED FOR SAVING LIVES:

Before:

- Determine the occurrence of heatwaves based on historical meteorological and health surveillance data together.
- Once the need and priority to have surveillance of the health effects of heatwaves has been determined:
  - develop impact-based heatwave thresholds for determination of events;
  - conceptualize the health effect surveillance system based on the results of a strategic risk assessment (Annex 3);
  - review the variables of the effect of heat or exacerbation of chronic diseases under International Classification of Diseases- (ICD) 10 or ICD-11 on morbidity and mortality (Annex 4), and define which will be used, or which other codes can be used as proxies;
  - develop/validate or adapt tools for reporting heatwave-related morbidity (*9*) and mortality (*10*).
- Identify and integrate surveillance actions with the heat action plans.
- Establish surveillance of heatwave morbidity and mortality in sentinel hospitals.
- Generate evidence-based information for risk prevention and communication actions.
- Define the reporting frequency and variables to be reported at the local level to the regional level (daily), and the regional level to the national level (weekly).
- Train surveillance operators and notify health facilities at different levels, as well as emergency regulatory centers of the importance and mandatory nature of mortality and morbidity reporting during an active heatwave.

During:

- Monitor how health effects evolve during the heatwave.
- Determine the geographic distribution of morbidity and mortality in clusters of vulnerable populations who require special care.
- Issue epidemiological alerts as necessary.
- Determine the end of the alert together with the NMHS.

After:

- Validate the data quality from the surveillance of heat-related health effects.
- Conduct studies on risk factors and the characterization of heat morbidity and mortality once the contingency has passed.
- Maintain monitoring of heatwaves, in coordination with the Emergency Operations Center and the NMHS, looking for changes in health effects according to heat or temperature changes.
- Analyze the utility of meteorological thresholds concerning health effects.
- Analyze the measures recommended and taken in response.

6.3 FORECASTING

The objective of impact-based forecasting is to have meteorological information on heatwaves based on valid information that is available on a timely basis to facilitate decision-making.

The NMHS should be proactive in creating a heatwave impact-based forecasting system, roles and processes based on the use of historical information, knowledge and experience, both national and international.

Based on prediction and forecasting, the NMHS together with the health sector analyze the threat and establish the risk to determine whether an alert should be issued in order to trigger readiness and preparedness actions in line with the heat action plan (*11, 12*).[3]

The NMHS and the health sector should agree on the number of consecutive days of heat to be used in the definition of a heatwave and the impact-based threshold of meteorological and climate variables for issuing an alert.

Guidelines and methods for temperature monitoring and how to jointly establish an early warning system between the NMHS and the health authority are provided in *Heatwaves and Health: Guidance on Warning-system Development* (*4*).

6.4 HEATWAVE CASE MANAGEMENT

The aim of case management is to ensure that there are mechanisms and resources for providing the timely care necessary to relieve, monitor, stabilize, and control signs and symptoms of heat-related illness. Health personnel are required to monitor symptoms of pre-existing chronic diseases that have been aggravated by heat. Case management is carried out at the individual, family, and community level on an outpatient basis or at health facilities that are part of the health network under the ministries of health or a similar organization (see Box 3).

BOX 3. Aspects to consider in case management during heat waves

- The use of the triage methodology should be promoted at health facilities with high patient demand to reduce waiting time for the most serious cases. This can save lives.
- Heat exhaustion and heatstroke should be investigated for every patient who manifests an altered state of consciousness.
- Specialists in critical medicine should know how to manage severe cases of heatstroke and the complications that may arise.
- Increased electrical usage and associated cost due to the increased demand for air conditioning should be taken into account.

[3] Illustrative examples of heatwave alert levels in line with a heat action plan can be found at: Government of Argentina. Cuidados de la salud ante una ola de calor [Internet]. Buenos Aires: Ministerio de Salud; (no date) [cited 15 Dec 2020]. Available from: www.argentina.gob.ar/salud/desastres/cuidados-oladecalor; and Government of Canada. Adapting to extreme heat events: guidelines for assessing health vulnerability. Ottawa: Health Canada; 2011 [cited 15 Dec 2020]. Available from: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/climate-change-health/adapting-extreme-heat-events-guidelines-assessing-health-vulnerability-health-canada-2011.html

For the development and implementation of the health sector's heat action plan against heatwaves, in its case management component:

- Facilitate the establishment of working groups of public health experts and clinical specialists to provide support on technical matters in their areas of specialization.
- Help identify financial and human resources, equipment, and supply needs for the treatment of heatstroke and heat exhaustion and cope with an increase in the expected cases of chronic diseases exacerbated by heat in risk areas.
- Ensure the availability of validated technical specifications and costs as inputs for the development of the procurement/equipment plan as part of the heat action plan.
- Promote a review and update of the national pre-hospital and hospital guidelines for managing heat-related cases and complications of associated chronic diseases. Recommendations on managing mild and moderate heat-related cases, and on the management of severe heatstroke can be found in Public Health Advice on Preventing Health Effects of Heat (*13*).
- Provide support on the preparation of contingency plans at the health facility level, which are developed together with the local authorities and operators.
- Provide support on cascade training according to the level of specialty.
- Ensure that health facilities complete the morbidity and mortality reporting tools for cases treated at each facility.
- Facilitate the joint work of specialists in case management and communication staff for the validation of materials.

6.5 COMMUNICATION

The purpose of communication (*7, 9*) is to ensure that audiences receive accurate, timely information. Planned communication is key to ensuring successful preparedness and response to a heatwave.

The communication component must be consistent with all aspects of the heat action plan:

- Establish timely, transparent, unambiguous communication that inspires trust and public support for the actions in the heat action plan.
- Alert the population about the possible risk of a heatwave and what to do to reduce the risk of heat-related health effects. Communicate what you know about the risk, actions that have been taken, and the level of uncertainty.
- Use language that will be understandable to the target audience of the message.
- Identify misinformation and quickly respond to rumors.

The communication plan:

- should be based on the risk assessment and diagnosis, should have strategic and operational components, and should consider internal and external communication;
- includes objectives, audiences, strategies, scheduling, times, costs, and tools;
- should have four components:
  - high-level advocacy: geared toward authorities and donors to mobilize support and resources;
  - communication of the alert and coordination between meteorology, health, and other sectors: aimed at an integrated response;

  - risk communication: aimed at raising public awareness of an imminent risk, and developed based on realities, perceptions, and risks;
  - communication for prevention and behavioral change: aimed at health workers and the public.
- should include messages that focus on target audiences with adapted content:
  - the authorities: information for decision-making;
  - the public: information related to the threat, the risks they face, prevention measures, measures to take to protect from and manage the risk, and what actions the authorities are taking;
  - health providers and operators: vulnerability criteria, interaction of heat and chronic diseases (Annex 5) and medications that have adverse effects when used during a heatwave (Annex 6);
  - partners who can support the action cooperation;
  - people or institutions issuing misleading messages.

Modes of communication include:

- interpersonal communication: visits, meetings, conversations by telephone or web conference with authorities, donors, heads of other sectors, doctors, nurses, employers, sports associations;
- public events: fairs, storytelling and theater;
- mass media: radio, television or print media, based on the target population, dissemination costs;
- social networks: Facebook, Twitter, and WhatsApp;
- Internal communication:
  - identify contact persons;
  - set up communication trees for internal communication at all relevant sectors.

In addition to information for the general public, targeted information should be provided for population groups at high risk of health effects from heatwaves: older people and very old people, or people with chronic diseases and their caregivers. This information should contain: practical tips (such as for keeping cool and well hydrated); information on first aid treatment; and important contact details for social and medical services, including ambulance services.

6.6 INTERVENTION STRATEGIES

Intervention strategies are part of the heat action plan; they aim to reduce the risk to health and increase resilience through physical, technological, or practical adaptation.

There are different levels of intervention, the individual, the community, and vulnerable groups. There are also strategies that can be geared to the period before and during a heatwave, and others that go beyond the heatwave and concern urban planning.

The implementation of intervention strategies depends on political will, available resources, the practical relevance of the intervention, and the feasibility of applying measures in the context of the Member State. Although intervention strategies have been developed in countries affected by heatwaves, most were tested in developed countries. As a result, it is necessary to work on generating evidence, both from the public health and meteorological perspectives, focusing on low-cost alternatives that would be easy to adapt to the economic and cultural context of Latin America and the Caribbean. Additionally, there is need to generate evidence of the different strategies in different meteorological zones. The risk of heatwaves in tropical areas should not be underestimated.

Goals

The goals of heat-related intervention strategies are:

- Maintain body temperature within an appropriate range.
- Recognize the signs and symptoms of heat stress in oneself and others.
- Know what actions to take in a heat-stress situation.

Interventions aimed at the local authorities and the general public are focused on public information and collective actions in line with local plans in support of the goals.

At the individual level

The aim is to provide individuals with messages to inform them on prevention, self-care (e.g., avoiding exposure, hydration, wearing light-colored and lightweight clothes), and providing caring for others. Emphasis should be placed on the timely recognition of signs and symptoms in vulnerable populations in order to initiate timely and appropriate treatment.

At the community level

Community participation is critical for disseminating information and ensuring the health and safety of the vulnerable population. Effective preparedness is not complete if the local authorities do not engage the community in the development of heat action plans.

Strategies at the community level to achieve the goals are: providing information on the start and duration of the threat; providing recommendations on precautions for groups at risk; and taking public measures. These measures include: cancelling outdoor activities; prohibiting electrical power and water suppliers from cutting off services due to lack of payment during the contingency; establishing public cooling centers with air conditioning; and transferring the vulnerable population to cooling centers or shelters.

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ANNEX 1. Definition of health effects of heatwaves, signs and symptoms

Medical condition	Signs and symptoms/mechanisms
Heat rash	Small, red, itchy papules appear on the face, neck, upper chest, under breast, groin and scrotum areas. This can affect any age but is prevalent in young children. Infection with Staphylococcus can occur. It is attributed to heavy sweating during hot and humid weather.
Heat edema	Edema of the lower limbs, usually ankles, appears at the start of the hot season. This is attributed to heat-induced peripheral vasodilatation and retention of water and salt.
Heat syncope	This involves a brief loss of consciousness or orthostatic dizziness. It is common in patients with cardiovascular diseases or who take diuretics before acclimatization takes place. It is attributed to dehydration, peripheral vasodilatation, and decreased venous return resulting in reduced cardiac output.
Heat cramps	Painful muscular spasms occur, most often in the legs, arms, or abdomen, usually at the end of sustained exercise.
Heat exhaustion	Symptoms include intense thirst, weakness, discomfort, anxiety, dizziness, fainting, and headache. Core temperature may be normal, subnormal, or slightly elevated (less than 40 °C). Pulse is thready with postural hypotension and rapid shallow breathing. There is no alteration of mental status. This can be attributed to water and/or salt depletion resulting from exposure to high environmental heat or strenuous physical exercise.
Heat stroke	It is a more advanced step than heat exhaustion. It occurs due to exposure to prolonged heat (heat stress) during heatwaves in summer and/or prolonged exercise once the mechanisms responsible for controlling body temperature have been exceeded. Body temperature rises rapidly above 40 °C. Affected people have alterations of the central nervous system such as stupor, confusion, or coma. Frequently, hot and dry skin, nausea, hypotension, tachycardia, and tachypnea are observed. If treatment is not administered, the person worsens, may go into a coma, have multiple organ failure and die.

Source: Adapted and updated from World Meteorological Organization, World Health Organization. Heatwaves and Health: guidance on warning-system development [Internet]. Geneva: World Meteorological Organization and World Health Organization; 2015. Available from: www.who.int/globalchange/publications/WMO_WHO_Heat_Health_Guidance_2015.pdf?ua=1

ANNEX 2. Summary of heatwave mortality reported in the Region of the Americas

Reported heatwaves affecting the Region[1] occurred in the following countries:

Argentina: There is scientific information available on the frequency of heatwaves in Argentina between 1961 and 2010.[2]

During the 2013/2014 season, three regional heatwaves were recorded: the December heatwave, which reached 17 provinces; the January heatwave, which reached 15 provinces; and the February heatwave, which reached four provinces. During the three heatwaves, 1,877 excess deaths were recorded, and the risk of death increased significantly in 13 of the 19 provinces analyzed, compared to the average of the same periods in the summers of 2010–2011 and 2012–2013 without heatwaves. Mortality by sex showed heterogeneity in the temporal and spatial scale: in December, the trend was similar for both sexes, while in January and February, the risk was higher for males. The risk of death increased with age; it was significant in four provinces for the 60–79 age group, and in six provinces for those over 80. The causes of death with significantly increased risk were respiratory, cardiovascular, cerebrovascular, renal failure, and diabetes.[3]

Brazil: In the summers of 2001 and 2014, there was a marked reduction in humidity and an increase in dry heat, which led to a severe water reserve crisis, with a deficit in electricity generation and an increase in the number of forest fires.

In 2010, the combination of a heatwave with abnormal weather generated a hot, dry air mass that remained on the southern coast of Brazil for a prolonged period of 10 to 15 days, causing an estimated 737 excess deaths in the metropolitan Rio de Janeiro region, especially among older people, women, and people with chronic conditions.[4]

Canada: Extreme heat is associated with increased illness and deaths, and poses a growing risk to the health of Canadians.[5] The evidence shows high numbers of deaths during previous extreme heat events in the country. For example, there was an estimated 106 heat-related deaths[6] during a three-day heat event in July 2010 in Montreal, Quebec. An analysis of the 2009 extreme heat event in British Columbia (an eight-day period where temperatures reached as high as 34.4 °C/93.9 °F) revealed that it contributed to 156 deaths in the province's lower mainland area.[7] In late June to early July 2018, a five-day heat event in eastern Canada

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[1] This table summarizes the situation of heatwave-related mortality in the Region. It is based on information available in the media, which is accessible via the Internet, given that official statistics on this subject are limited. It is for illustrative purposes and is intended to be updated whenever official information is available.

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broke several temperature records in several cities including Ottawa and Montreal. The media reported an estimated 70 deaths attributable to this event in the province of Quebec.

Chile: Every summer from 1981 to 2010, an average of one to two heatwaves was recorded. However, from 2011 to 2017, the country recorded an extreme increase in the number of heatwaves of up to five per season; some lasted three days and were limited to the local level, while others were widespread, affecting the entire Chilean territory.

In 2017, heatwaves were recorded throughout most of Chile. In areas such as Curicó, some heatwaves lasted 16 days in a row, which is very difficult to withstand. Temperatures reached record levels in Curicó and Santiago, rising above 37.3 °C. The highest temperatures occurred in Chillán and Los Angeles, from 41.5 °C to 42.2 °C. These heatwaves created favorable conditions for forest fires that were considered the worst that had ever affected the country.[8] In addition to heat stress, the main effect reported in humans was the difficulty that people had sleeping due to high temperatures at night.[9]

Mexico: In 2018, the thermometer reached temperatures of 45 °C to 50 °C, particularly in Chihuahua, Guerrero, Coahuila, and Oaxaca.[10] According to the Weekly Epidemiological Surveillance Report for Extreme Temperatures issued by the Ministry of Health of Mexico,[11] through week 34 of 2018, there were 26 deaths nationwide compared to 19 in 2017. Heat-related deaths increased in the age groups from 25 to 44, and 45 to 64 years. Regarding heat-related morbidity, through epidemiological week 34, 251 cases of heatstroke and 320 cases of heat exhaustion were reported. The states with the largest number of cases were Sonora and Baja California, which together have nearly 50% of the cases of heatstroke and heat exhaustion. According to this report, every year, approximately 1,200 cases of heatstroke and 15 heat-related deaths are recorded.

Nicaragua: In 2017, a heatwave caused at least four deaths — two 35-year-old men and two 47-year-old women suffered from cardiovascular and respiratory conditions, one of whom had a history of alcohol use.[12]

Peru: In 2016, during the heatwave that affected Piura with temperatures up to 37 ºC, eight minors died, with a diagnosis of a possible heatstroke. They had recurrent fever of up to 40 ºC for several days, dehydration, diarrhea, and convulsions.[13]

United States of America: Heatwaves were recorded in 1896, 1901, 1911, 1936, 1972, 1980, 1995, 2000, 2001, 2006, 2007, 2011, 2012 (two events), and 2018.[14] The United States is the country in the Region that has best documented the effect of heatwaves. A review of the frequency of heatwaves conducted by the authors identified that more than 57% of heatwaves recorded between 1896 and 2018 occurred within 18 years (from 2000 to 2018), while the remaining 43% occurred within 100 years.

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The health-related heat effects are summarized in Table A2.1.

Table A 2.1. No. of deaths caused by heatwaves per country

Reporting country	Year	Number of deaths	Temperature	Number of heatwave days	State or province
Argentina	2013 2014	1,046 831	NA NA	3 to 17 (X=6.94) 3 to 13 (X=5.7)	7 provinces 9 provinces
Brazil	2010	737	35–39 °C	10 a 15	Southern coast and Rio de Janeiro
Canada	2009 2010 2018	156 106 70	34.4 °C MA 35 °C	6	
United States*	1896 1901 1911 1936 1972 1980 1995 2000 2001 2006 2007 2011 2012 2018	200 9,500 358* 5,000 1,700 739 140 25 225 105 75 82 -	NA	NA	Several states affected (preliminary information, illustrative purposes, to be reviewed)
Mexico	2017 2018	19 26	NA NA	NA NA	National surveillance National surveillance
Nicaragua	2017	4	39 °C		Chinandega
Peru	2016	8	35 °C	NA	Piura
Total		20,818			

Source: Compiled by authors. Press releases, scientific publications, and country epidemiology reports, accessible via the Web.
Note: * In the United States alone, 17,791 deaths are attributed to heatwaves, compared to 2,716 in the rest of the Americas.

ANNEX 3. Guidelines for conceptualizing heat morbidity and mortality surveillance

The epidemiological teams at the municipal, departmental, regional, and national levels are responsible for monitoring morbidity and mortality. They should report to the department of epidemiology, which in turn should report to the emergency operations center of the Ministry of Health, when the data suggest heat-related health effects.

Information on mortality and morbidity is essential for assessing the severity of the effect of a heatwave, evaluating the effectiveness of morbidity and mortality prevention actions, and defining actions and strategies.

Surveillance should not be limited to death or illnesses coded directly as heat, but should also cover the exacerbation of chronic disease, all cause excess mortality, and the presence of other known conditions related to heat.

Morbidity surveillance: This should be based on an urgent care reports from reference health facilities and hospitals. Countries that have social security, private operators, and/or emergency regulatory centers to manage ambulances should ensure mechanisms to integrate information from these sources. A comparison will be made with the daily historical records to detect days with unusual demand for treatment.

Mortality surveillance: This includes all cause excess mortality reports, and can be complemented with data from vital records online, if available. Additionally, mortality data from other sources (funeral homes or cemeteries) can be used to identify variations in mortality compared to historical records in order to detect unusual days in terms of mortality.

ANNEX 4. ICD-10 and ICD-11 codes for heat-related health effects

The International Classification of Diseases (ICD) codes for heat exposure effects are listed in the "Exposure to forces of nature" section, where ICD-10 mentions "exposure to excessive natural heat," coded as X30, and in ICD-11 as "exposure to extreme forces of nature." However, this section omits reference to "exposure to excessive natural heat." Table A4.1 lists conditions caused by heat and their respective codes under ICD-10 and ICD-11.

Table A4.1 The International Classification of Diseases (ICD) codes for heat-related health effects

Heat Effects ICD-10	ICD-10 Diagnostic Table*	Heat Effects ICD-11	ICD-11 Diagnostic Table**
Effects of heat and light	T67	Effects of heat	NF01
Heatstroke and sunstroke	T670	Heatstroke	NF01.0
Heat syncope	T671	Heat syncope	NF01.1
Heat cramp	T672	Cramps resulting from loss of fluids and electrolytes due to heat	NF06.3 This is the closest category for heat cramps.
Heat exhaustion due to depletion of fluids and electrolytes	T673	Heat exhaustion due to depletion of fluids and electrolytes	NF01.2
Heat exhaustion due to salt depletion	T674		
Heat exhaustion, unspecified	T675		
Heat fatigue, transient	T677	Heat fatigue	NF01.3
Heat edema	T677		
Other effects of heat and light	T678	Other specific effects of heat	NF01.AND
Effect of heat and light, unspecified	T679	Non-specific effects of heat	NF01.Z
		Exertional heatstroke (new)	NF06.0
Sweat rash/miliaria	L74.0 Heat rash is the closest category. Review the availability of a specific category for heat rash in children.		

Source: World Health Organization. International Classification of Diseases (ICD) [Internet]. Geneva: World Health Organization; (no date). Available from: www.who.int/classifications/icd/en

Notes: * International Classification of Diseases 10, 2018. Available at: https://icd.who.int/browse10/2016/en

**International Classification of Diseases 11, 2018. Available at: https://icd.who.int

ANNEX 5. Health conditions/chronic diseases that create high risk during a heat wave

Health conditions	Mechanism	Selected evidence
Diabetes mellitus, other endocrine disorders	• Types 1 and 2 diabetes are associated with impairment in skin blood-flow response, which may play a role in reducing heat dissipation. • Sweating responses may also be reduced. Metabolic alterations can occur.	Bouchama et al., 2007 Kovats & Hajat, 2008 Kenny et al., 2010 Schifano et al., 2009
Organic mental disorders, dementia, Alzheimer's disease	• Reduced awareness of heat-related risks and adaptive behaviors, high dependency level, interaction of many medications with the body's ability to thermoregulate.	Belmin et al., 2007 Faunt et al., 1995
Substance misuse disorders	• Changes in physiological response mechanisms and changes in behavior due to psychoactive substances and alcohol.	Kovats & Hajat, 2008
Schizophrenia, schizotypal and delusional disorders	• High level of dependency, prescribed psychotropic drugs.	Bouchama et al., 2007 Kovats & Hajat, 2008
Neurological diseases, e.g. Parkinson's disease and those involving cognitive impairment	• Potentially limited awareness and mobility; high level of care dependency, prescribed psychotropic drugs.	Kovats & Hajat, 2008
Cardiovascular diseases (including hypertension, coronary artery disease, heart conduction disorders)	• Impairment of thermoregulatory responses and high risk of acute coronary and cerebral thrombosis, reduced cardiovascular and thermoregulatory responses and changes in blood composition due to dehydration (1% of body weight deficit). • Changes in renal function may be related to life threatening, cardiac rhythm disturbances in older patients. • Worsening of the existing condition, cardiovascular, thermoregulatory, and blood changes in hypertensive patients followed by a sudden fall in arterial pressure may lead to fatal cerebral ischemia. • Peripheral circulatory changes may lead to reduction in core temperature regulation.	Carberry, Shepherd, & Johnson, 1992 Keatinge et al., 1986 Kenny et al., 2010
Diseases of the respiratory system, chronic lower respiratory disease	• Combined effect of high temperature and air pollution on the pathogenesis and clinical history of respiratory diseases (i.e., asthma, chronic bronchitis). • Worsening of existing condition (i.e., chronic obstructive pulmonary disease [COPD]), due to hyperventilation and dyspnea) and difficulty in dissipating excess heat (e.g., peripheral vasodilatation, hypovolemia).	Ren et al., 2008 Sprung, 1980 Stafoggia et al., 2008 Schifano et al., 2009
Diseases of the renal system, renal failure, kidney stones	• Diminished renal function due to the electrolyte and water imbalance consequent to hyperthermia and dehydration, especially in older people.	Flynn, McGreevy, & Mulkerrin, 2005

Health conditions	Mechanism	Selected evidence
Obesity	• Sensory impairment to heat, or reduced capacity for heat dissipation due to the smaller ratio of body surface area to body mass that hampers sweat evaporation.	Herman et al., 2007 Kenny et al., 2010
Other chronic diseases	• Examples: lack of sweat glands in people with scleroderma, high loss of electrolytes through sweating in those with cystic fibrosis.	Orenstein, Henke, & Green, 1984 Paquette & Falanga, 2003

Source: Extracted from World Health Organization. Public health advice on preventing health effects of heat [Internet]. Geneva: WHO; 2011 [cited 15 Dec 2020]. Available from: https://www.who.int/publications/i/item/public-health-advice-on-preventing-health-effects-of-heat

ANNEX 6. Medication that influences thermoregulation and fluid balance

Medication	Mechanism
Anti-cholinergic	Can affect central thermoregulation, reduce cognitive alertness, and prevent or reduce sweating (many drugs below have anti-cholinergic effects).
Antipsychotics	Can inhibit the sweating mechanism and reduce systolic blood pressure, central thermoregulation, cognitive alertness, and vasodilation.
Antihistamines	Can inhibit the sweating mechanism, and reduce systolic blood pressure.
Anti-Parkinson agents	Can inhibit the sweating mechanism, reduce systolic blood pressure, and cause dizziness and confusion.
Antidepressants	Reduce sweating, some can decrease centrally induced thermoregulation and cognitive alertness.
Anxiolytics and muscle relaxants	Reduce sweating and increase dizziness, decrease cardiac output and therefore reduce cooling by vasodilation, and worsen respiratory symptoms.
Antiadrenergic and beta-blockers	Can prevent dilation of the blood vessels in the skin, reducing the capacity to dissipate heat by convection.
Sympathomimetics	Can worsen hypotension in vulnerable patients, specifically vasodilators, including nitrates and calcium channel blockers.
Antihypertensives and diuretics	Can lead to dehydration and reduce blood pressure; hyponatremia is a common side effect and can be worsened by excess fluid intake.
Antiepileptics	Can reduce cognitive alertness and increase dizziness.
Other drug classes, such as antiemetics, anti-vertigo drugs, gastrointestinal drugs, urinary incontinence drugs	Also have anti-cholinergic effects.

Source: Extracted from World Health Organization. Public health advice on preventing health effects of heat [Internet]. Geneva: WHO; 2011 [cited 15 Dec 2020]. Available from: https://www.who.int/publications/i/item/public-health-advice-on-preventing-health-effects-of-heat

This publication presents a comprehensive methodology to support the Member States of the Pan American Health Organization (PAHO) in preparing for and responding to heat-health risks in the Region of the Americas. It builds on World Health Organization and World Meteorological Organization global documents, as well as on the disaster preparedness methodologies employed throughout the countries of the Region.

This publication is part of an effort coordinated by PAHO to support Member States in multihazard preparedness, and includes: early warning system strengthening; threat characterization; activation and deactivation procedure definition; and institutional coordination. It engages different disciplines and recognizes the importance of intersectoral collaboration to respond to heat-health risks. It aims to bring awareness of the impacts of heat on the health of people of the Americas to public health decisionmakers, and thereby strengthen health service provision.

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