Research for Action on Climate Change and Health in the Caribbean:
A Public, Private, People's and Planetary Agenda

Caroline F. Allen[1], Renée M. West[1], Georgiana Gordon-Strachan[2], Saria Hassan[3], Shelly McFarlane[2], Karen Polson-Edwards[4], Audreyanna Thomas[4], C. James Hospedales[5*], Robert Dubrow[6*]

[1]Blue Sky Development Consulting
[2]Caribbean Institute for Health Research, The University of the West Indies
[3]Rollins School of Public Health, Emory University
[4]Pan American Health Organization
[5]EarthMedic and EarthNurse Foundation for Planetary Health
[6]Yale Center on Climate Change and Health, Yale School of Public Health
[*]Co-chair

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6. HEAT-RELATED ILLNESS

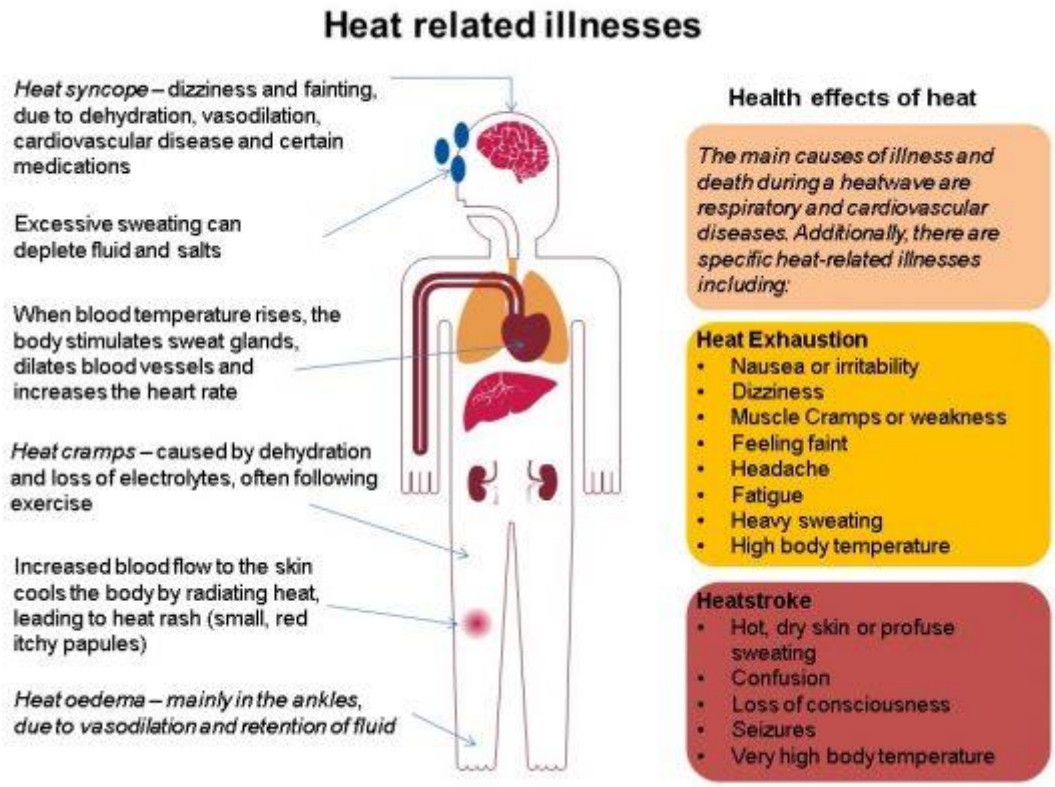
6.1. WHAT IS HAPPENING?

The Intergovernmental Panel on Climate Change states that extreme ambient air temperature is associated with elevated mortality (with "very high confidence") and morbidity (with "high confidence") (Cissé et al., 2022). In the Caribbean, there has been a steady rise in air temperature since the early 1990s. Between 1991 and 2021, the region warmed at a rate of 0.24 °C per decade. The average temperature in 2021 was 0.68 °C higher than the 1961–1990 average (WMO, 2021). The number of very warm days and nights across the Caribbean is increasing, while the number of cool days and nights is decreasing (Climate Studies Group Mona, 2020; Stephenson et al., 2014). In 2020, the Caribbean experienced record-breaking heat; new air temperature records were set in Cuba, Dominica, Grenada and Puerto Rico (WMO, 2021). In the second half of 2017, when Hurricanes Irma and Maria hit, surface temperatures were some of the highest ever recorded (Stephenson et al., 2018). Extreme heat may occur in concert with other extreme weather events that can have additional negative health impacts (Taylor, 2021).

Extreme heat exposure can compromise the body's ability to cool itself. Heat-related illnesses include heat rash, heat cramps, heat exhaustion, heat syncope (fainting or dizziness) and heat stroke. Extreme heat can also trigger acute health events, including acute kidney failure and acute myocardial infarction, and can exacerbate preexisting noncommunicable diseases (NCDs), such as heart or lung disease. Several of these illnesses (e.g. heat stroke, acute myocardial infarction), if not treated immediately, can be fatal. Activation of the body's heat defence mechanisms leads to cutaneous vasodilation, which increases blood flow to the skin, thus promoting heat transfer from the body to the skin and then to the ambient air. Extreme heat can result in reduced blood circulation in the body and, particularly if someone is in a standing position, subsequent heat syncope. Electrolyte imbalance due to sweating, the body's other major heat defence mechanism, can cause heat cramps. Symptoms of heat exhaustion, usually associated with electrolyte imbalance and dehydration, include fatigue, heavy sweating, a rapid pulse, anxiety and confusion, and elevated body temperature. Signs of heat stroke, which is considered a medical emergency, include a body temperature greater than 40 °C, loss of consciousness, hot dry skin with no sweating, severe central nervous system abnormalities (e.g. delirium, convulsions) and multi-organ dysfunction (Di Napoli et al., 2023; Székely et al., 2015; Taylor et al., 2010). See Figure 1.

In 2020, results from a global survey of over 4600 health professionals from 12 countries, including Jamaica, indicated that heat-related illnesses were already affecting local populations and that these illnesses were expected to become more frequent or severe within the next 10 years (Kotcher et al., 2021). A 2013 study in Grenada and Trinidad and Tobago used focus group discussions to explore perceptions among Caribbean healthcare providers about the health impacts of increasing temperatures. The groups included physicians and nurses, with at least one veterinarian and technician in each group. Participants in both groups perceived air temperatures as hotter than usual and as contributing to more heat-related illness and hospital admissions. Participants in Grenada described an increase in hospitalisations for dehydration and sunburn. Participants from Trinidad and Tobago talked extensively about heat stress, chronic obstructive pulmonary disease and increasing numbers of deaths of working and domestic animals. A veterinarian described putting dogs on fluids to save their lives after they had collapsed from heat stress (Macpherson and Akpinar-Elci, 2015). A knowledge, attitudes and practice survey by the Caribbean Environmental Health Institute demonstrated that 75% of hotel nurses in Barbados and Saint Lucia noticed a seasonal pattern of sunburn, peaking between April and September. However, over 80% of public health doctors and nurses and environmental health officers, in both countries, noticed no year-to-year or seasonal patterns (Taylor et al., 2010).

Figure 1: Heat-related illnesses



Source: Landeg and Extreme Events and Health Protection team (2020);
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The relationship between heat exposure and mental health is an additional area of concern, as there is evidence from other regions of the world that heat exposure may be associated with performing violent acts, general irritability, higher levels of anxiety and stress, and increased accident and emergency admissions for mental disorders (Cissé et al., 2022; R4ACCHC, 2022a; WMO, 2021). The impacts of heat exposure on cognition add to concerns. In the Eastern Caribbean states, excessive heat exposure has the potential to reduce children's learning ability at school, indicating the need to make school environments cooler (R4ACCHC, 2022b; Van Meerbeeck, 2020). Furthermore, older people are particularly vulnerable to higher ambient air temperatures, which can result in cognitive impairments (Yi et al., 2021).

The "urban heat island" effect causes temperatures to be higher in urban areas than in rural areas, as dense concentrations of pavement, buildings and other surfaces absorb and retain heat. Night-time radiant energy from heat that builds up and is stored in built structures reduces the extent to which buildings cool down at night (Campbell-Lendrum and Corvalán, 2007; Taylor et al., 2010), depriving people of night-time relief from the heat. This is an important concern, as 52% of Caribbean people live in urban areas (World Bank, 2021). Air pollution episodes are also frequently associated with heatwaves. In addition, extreme heat affects health through its impact on air and water quality, food and water availability, infectious agents and ecosystems, and through population displacement (CARPHA, 2018; Walsh et al., 2018).

Vulnerability to extreme heat is determined by demographic factors associated with social disadvantage and biological difference (e.g. age, gender and race/ethnicity) and social factors (e.g. poverty, usual place of residence [which affects the levels of heat that individuals are accustomed to], housing and infrastructure, occupation, discrimination, access to health care and preexisting conditions). Specific vulnerable groups include the elderly, pregnant women, children, people with preexisting NCDs, people experiencing homelessness,

outdoor workers, people living in poverty in urban areas and tourists not accustomed to warm weather. The likelihood of ill health is, of course, compounded for people who belong to more than one of these groups (Allen, 2021; USGCRP, 2016).

Extreme temperatures put a strain on the operation of, and access to, healthcare facilities and services. Ambulance call-outs and hospitalisations for acute heat-related illnesses tend to increase on hot days. Air-conditioning systems work harder to maintain a comfortable indoor temperature and may therefore break down more often. Storing medicines at a safe temperature may also be challenging (Macpherson and Akpinar-Elci, 2015; Méndez-Lázaro, 2021; WHO, 2018). High outdoor temperatures may lead to low attendance at health facilities, even in the Caribbean. Many smaller and rural health clinics have seating areas that are not air-conditioned, making attendance uncomfortable on particularly hot days. More modern health facilities generally have air conditioning but lack windows; this can be challenging during power outages, which often happen in the immediate aftermath of a hurricane (R4ACCHC, 2022c).

Although the adverse health effects of heat exposure have been increasingly studied globally, studies on heat-related illnesses in the Caribbean are limited. Given the high prevalence of NCDs in the Caribbean, it is reasonable to hypothesise that heat-related illness in the region might be an underappreciated problem that is being made worse by increasing temperatures due to climate change. See Chapter 4, “Noncommunicable diseases and risk factors”.

Di Napoli et al. (2023) demonstrated a positive correlation between increased air temperature and heat stress in the Caribbean between 1980 and 2019, using a measure called the Universal Thermal Climate Index.[1] Therefore, the risk of heat-related illness and death is expected to increase with increasing ambient air temperatures, especially among vulnerable groups (Allen et al.,2021; Ebi et al., 2006; Pascal et al., 2021; Taylor et al., 2010). Pascal et al. (2021), using a non-linear generalised model linking temperature and mortality, demonstrated an association between higher temperatures and increased risk of mortality between 2000 and 2015 in French Guiana, Guadeloupe, Martinique and the French overseas territories in the Indian Ocean.

Mendéz-Lazaro et al. (2021) examined the environmental stressors experienced by women with gynaecological cancers from Puerto Rico and the United States Virgin Islands who received care in the aftermath of Hurricanes Irma and Maria in Puerto Rico. Focus groups with patients and healthcare providers ranked heat as the number one environmental stressor, followed by air and noise pollution. Cancer patients are known to suffer more in the heat because they experience hot flashes. It was also noted that temperatures were “above normal” (greater than 38 °C) for five consecutive days after the hurricane.

> Remember that patients who are undergoing chemotherapy suffer a lot from heats and hot flashes; they sweat more (often), and they are sick. Some of them vomit, and not even having (electricity) a fan to cool off when you feel sick is not comfortable. Not having ice to cool your organism inside, that’s what patients complained the most.
>
> Méndez-Lázaro et al. (2021)

[1]Di Napoli et al. (2023) reanalysed 1980–2019 data to explore the correlation between climate change and heat stress in the Caribbean. They used a multivariate thermophysiological-relevant parameter – the Universal Thermal Climate Index (UTCI) – to represent thermal conditions and its variability. The UTCI reflects the bodily temperature felt under the combined environmental variables of temperature, relative humidity, wind speed and solar radiation; it is used as a reference to measure human thermal discomfort and therefore the environmental conditions that cause strain. This study found a regional increase in the UTCI of more than 0.2 °C per decade, with the Lesser Antilles having a UTCI increase of 0.45 °C per decade. Another biometeorological index – the heat index – which combines air temperature and relative humidity as an index of perceived temperature, has risen by 1.2 °C in the Caribbean since 1980.

The Caribbean Institute for Meteorology and Hydrology (CIMH) is working on collecting data, starting in Grenada, that can be used to study the link between climate change and heat-related illnesses (Allen et al., 2021). This will be important in bolstering early warning systems, for not only the health sector but also the agriculture, construction and tourism sectors (R4ACCHC, 2022c). The Caribbean Institute for Health Research at the University of the West Indies in Jamaica is hoping to develop a surveillance system that links temperature data with data on NCDs (Allen et al., 2021).

6.2. WHAT SHOULD BE DONE?

Individual and community actions and how to support them

Increase knowledge of the risks of heat-related illness and their management among the general population and vulnerable people

Given the increasing ambient temperatures and increasing duration, intensity and frequency of heatwaves in the Caribbean, behaviour change to mitigate the risk of heat-related illnesses must be promoted. Individuals need to keep themselves and their immediate environment cool. Particular attention needs to be paid to health-promotion strategies for vulnerable people such as the elderly, pregnant women, infants and people with NCDs. Recommendations for staying healthy in high temperatures include the following (PAHO, 2018; UKSHA, 2018; WHO, 2018):

- Keep your living space as cool as possible, ideally below 32 °C during the day and below 24 °C at night. This is particularly important for the elderly, infants and people living with NCDs:
    - Use natural air to cool down your house. Open windows in shaded or breezy areas. Install ventilator blocks and windows that allow a breeze to flow through indoor spaces where no air conditioning is installed.
    - Reduce heat load during the day. Close windows and/or curtains facing direct sunlight to prevent excess heat entering the house. Turn off as many electrical devices as possible.
    - When using air conditioning, keep all windows and doors closed.
    - Use fans to improve air flow.
- Keep out of the heat by staying in the coolest part of the house, avoid going outside and avoid strenuous exercise, especially during the hottest times of the day. Stay in the shade.
- Do not leave animals or small children in parked vehicles.
- Keep your body cool by taking cool showers often; wearing light, loose-fitting clothes; using light bed sheets at night; drinking fluids regularly, but avoiding caffeine, sugary drinks and alcohol; and eating small meals and eating more often. Avoid excessive consumption of foods that are high in protein.
- Get help if you do not feel well.
- Help others who are vulnerable. Check in regularly with vulnerable people in your community such as older people and people with disabilities.
- Store medications as per the storage guidelines, but, as a general rule of thumb, keep them below 25 °C or in the refrigerator.

This information needs to be disseminated to the general public and vulnerable groups before, during and after heatwaves. Social media and more traditional communication methods, such as radio, television and megaphone announcements in local neighbourhoods, can be used. Collaboration between the ministries responsible for health, education, social services and sport is important, to ensure that the appropriate information reaches the correct audience. As increased information does not always lead to behaviour change, health-promotion strategies must be designed in ways that respond to community experiences and include evidence-based behaviour-modification strategies. Skilled communication and health-promotion specialists are needed to develop such programmes (R4ACCHC, 2023a).

Structural/governmental and private sector actions

Develop national and local response plans for extreme heat

National response plans for extreme heat should be developed, including disaster preparedness measures. Saint Lucia has such a response plan (Government of Saint Lucia, 2006; NOAA NWS, 2016). These plans should include early warning systems to alert the public of impending heatwaves, provide emergency shelters for vulnerable

people that are equipped with high-powered fans or are air-conditioned, and allocate responsibilities to government agencies such as the ministries responsible for health and agriculture. In addition, local (e.g. municipal) response plans should be developed in the larger Caribbean countries/territories and for specific events such as outdoor sports and cultural events when the temperature is expected to be above normal (R4ACCHC, 2023a).

Train healthcare professionals and first responders in special medical needs associated with heat-related illness

This training can be a collaboration between national and regional academic institutions. Medical professionals can be trained as part of their learning curriculum. Special attention should be given to the delivery of medical care in emergency situations involving heatwaves and prolonged high temperatures (R4ACCHC, 2022b).

Improve health facility design to optimise cooling, including by having energy-efficient temperature control systems

It is important to improve the design of health facilities so that cooling can be optimised. This is particularly important for patients, both in hospitals and in outpatient care. Cool temperatures are also critical for the functioning of medical instruments and technology, such as diagnostic equipment; operating theatres; and medicine storage. If air conditioning is unaffordable at some facilities, fans and the optimisation of air flow, shading (e.g. verandas, trees), high-albedo roofs or green roofs, and building materials with high thermal mass should be built into design. Even when air conditioning is available, these building design features can reduce the energy needed for air conditioning. The Smart Health Initiative of the Pan American Health Organization (PAHO) provides blueprints for improving the structural safety of health facilities themselves, reducing energy consumption, water conservation and using environmentally friendly appliances and fixtures. This includes replacing older air-conditioning units with more energy-efficient models (CARPHA, 2018; PAHO, 2013). This will be discussed in more detail in Chapter 16, “Smart health facilities”.

Provide support for the installation of energy-efficient air conditioning and other cooling solutions that reduce demand for air conditioning

As the climate gets progressively hotter in the Caribbean, more people are likely to require air conditioning in at least one room in their home and in indoor work settings. A combination of fiscal measures and grants may be used to ensure that everyone has access to sustainable cooling solutions. In Barbados, tax breaks are available for the installation of solar power and other renewable energy systems that can be used for air conditioning. It is important to provide support for other cooling solutions, such as high-albedo roofs and insulation, which may be more affordable than air conditioning.

Develop national occupational heat standards

Some workers are exposed to high temperatures owing to the conditions of their work. It is evident that outdoor workers such as farmers and construction workers are at high risk of extreme heat exposure, but indoor workers in workplaces without air conditioning or other cooling solutions can be at high risk as well. Governments should develop standards to protect workers, such as mandatory rules on the provision of water, rest and shade for outdoor workers, according to the ambient temperature and physical demands of the work; on appropriate clothing and personal protective equipment; on the adjustment of work schedules to avoid working in the hottest part of the day; on the acclimatisation of new workers; and on an indoor temperature threshold above which workers are automatically dismissed from work (NIOSH, 2016).

Research gaps and how to address them

Identify how increases in ambient temperature affect the healthcare system

It is important to identify how heatwaves and increased ambient temperatures affect health systems in the Caribbean. This can improve the effectiveness of emergency preparedness planning and other adaptation measures. For example, are high ambient temperature and heatwaves associated with increased accident and emergency visits or hospitalisations due to specific heat-related illnesses? How do they affect the storage of medicines and the performance of medical equipment (Dubrow, 2021; WHO, 2018)? Answering these questions will enable the better alignment of resources for critical and emergency health service delivery.

More broadly, extreme heat can affect infrastructure, which in turn can affect health. For example, the integrity of water pipes, building materials and roads can be affected, and there will be costs associated with adapting vehicles, homes, workplaces and outdoor facilities as the Caribbean gets hotter (R4ACCHC, 2023a).

Citizen science and research

Individuals, communities and nongovernmental organisations should be included in research at the community level on experiences and impacts of rising temperatures and heatwaves (R4ACCHC, 2023b). For example, since 2017, the National Oceanic and Atmospheric Administration (NOAA) has been collaborating with volunteers and community groups in mapping the urban heat island effect in 60 cities across the United States of America. In Brooklyn, New York, in 2022, approximately 800 people with sensors attached to their cars or bikes followed set routes, measuring air temperatures and humidity levels while also collecting location data. Thanks to the assistance of citizen scientists, over 1 million measurements were gathered over 16 days, covering 6000 square kilometres (Poon, 2022; R4ACCHC, 2023c). In 2023, NOAA plans to collect data in Freetown, Sierra Leone, and in Rio de Janeiro, Brazil. Caribbean regional climate and health organisations can collaborate with volunteers and community groups to conduct similar mapping exercises.

Explore the relationship between increased ambient temperature and morbidity and mortality

The precise threshold at which temperature becomes a hazard to human health varies by region and depends on factors such as humidity, wind, local acclimatisation and preparedness for increased heat conditions (WHO, 2018). The impact of heat on health and the relationship between increased ambient air temperatures and heat-related illnesses in the Caribbean should be researched, with emphasis on vulnerable groups, including people living with NCDs; tourists; outdoor workers; the elderly; women, including pregnant and menopausal women; young children; people without access to indoor cooling; and people on certain medications (Allen et al., 2021; Dubrow, 2021). It is important to develop information that is specific to the Caribbean, to ensure that any interventions at the individual, community and structural levels are appropriate for the Caribbean region and its populations (R4ACCHC, 2023a).

CIMH is working on identifying temperature thresholds that can trigger morbidity and mortality outcomes, such as accident and emergency visits, hospitalisations and cause-specific or all-cause mortality (Allen et al., 2021). Such information is valuable for the development of early warning systems. Similarly, a project in Grenada is seeking to identify heat impact thresholds (see Box 1).

Box 1: Case study – pilot project to establish a heat threshold in Grenada: a model for the Caribbean region

In 2021, PAHO funded and facilitated a pilot project to analyse the relationship between extreme heat and other climate drivers and health in Grenada. Instead of using just one proxy outcome to determine heat impact on health thresholds, the pilot used hospital admissions, visits to accident and emergency and all-cause mortality. It is hoped that this methodology can be used in other Caribbean countries to assist with evidence-based policy development.

Source: Glasgow (2021).

Using biometeorological indices such as the Universal Thermal Climate Index (Di Napoli et al., 2023), research priorities may include exploring (Dubrow, 2021):

- The health effects of both short- and long-term heat exposure;
- The differences between men and women in terms of the health effects of heat exposure;
- The role of acclimatisation to heat in the Caribbean;
- How increased ambient temperatures affect new (e.g. COVID-19) and reemerging diseases in the Caribbean context.

Determine the effectiveness of actions at the individual, community, structural/governmental and private sector levels

Actions need to be evaluated to ensure that they are effective. Evaluations may be of process, impact and/or cost-effectiveness. Determining the barriers to and facilitators of implementing suggested actions would also be helpful in making recommendations for the way forward. Research questions could include the following:

- Following health-promotion interventions, are people, especially vulnerable populations, more knowledgeable about ways of keeping their living space and their bodies cool during the hottest periods of the day?
- Is the public aware of what needs to be done before and after an extreme weather event to mitigate heat-related illnesses?
- Are there sufficient numbers of healthcare professionals and first responders trained in the medical needs associated with heat-related illnesses?
- Are diagnostic equipment and supplies and medicines consistently being stored at the correct temperatures, even during periods of abnormally high temperatures?
- What proportion of the population has taken up offers of government tax breaks for the installation of efficient air-conditioning units or renewable energy systems for cooling?

Surveillance gaps and how to address them

Monitor and evaluate changes in ecosystems due to extreme heatwaves

It is important to preserve ecosystems, as climate change, including increased temperatures, can cause disruptions, especially in the food chain. An example from Alaska (Box 2) may provide pointers on how a similar monitoring system could be implemented in the Caribbean, involving local communities.

Box 2: Case study: Community-based surveillance led by the Alaska Native Tribal Health Consortium

In Alaska, several eco-system and health consequences of warming and of the heatwave that occurred in 2016 were identified using a community-based surveillance system (the Local Environmental Observer [LEO] Network) established by the Alaska Native Tribal Health Consortium. This system used cell phones to record incidents of environmental change via photos and text, validated through expert investigation and commentary. The warming conditions favoured some phytoplankton species, and one of the largest harmful algal blooms on record reached the Alaska coast in 2015. There were uncommon paralytic shellfish poisoning events and oyster farm closures in 2015 and 2016. Dramatic mortality events in seabird species such as common murres in 2015/16 (tens of thousands of dead birds were counted) were attributed to starvation and presumed to be a result of warming-induced effects on the birds' food supply. Increased occurrences of animal diseases were also observed, including sea star wasting disease. Human communities, especially native communities, were affected by changes in the acquisition, preservation, quality, and quantity of wild foods (Walsh et al., 2018). The LEO Network community-based surveillance system has potential for adaptation to the Caribbean, to utilise local observations and knowledge to enhance responses and adaptation to climate change.

Source: LEO Network (2021).

Include alerts for above-normal temperatures in climate change and health impact early warning systems

Early warning systems (see Chapter 11, "Research and surveillance on climate change and health", for further details) are intended to give notice of impending hazards in a timely manner to allow for preparation, prevention and mitigation activities that will reduce harm (Harewood, 2021). For this to happen, meteorological monitoring (ambient air temperature and humidity), health monitoring (heat-related illnesses and mortality) and systems to link the two types of monitoring are needed. It is important that such information is distributed effectively to healthcare workers as well as the general population, including visitors to the country (R4ACCHC, 2022c). Communication methods such as social media and traditional methods such as radio and television need to be employed.

Monitor and map the incidence of heat-related illnesses

Data on heat-related illnesses are not usually reported on a routine basis and thus the linkages between increases in heat-related illnesses and extreme weather events are usually examined only as part of a research project, such as Méndez-Lázaro et al.'s (2021) examination of the adverse health effects of the heatwave that occurred post Hurricane Maria.

Heat-related illnesses need to be routinely reported, with data collated and analysed at the national and regional levels. Sociodemographic differences in incidence should be identified so that adaptation measures tailored to specific groups can be developed. Population data should be collected according to age, sex and occupation, and climate data should include information on both temperature and humidity (R4ACCHC, 2023a).

Illnesses should also be geographically mapped against temperature data to identify localities where interventions to prevent and treat illnesses should be concentrated (R4ACCHC, 2023a).

Research and surveillance capacity-strengthening needs

In the Caribbean, CIMH collects national climate and environmental data, including on temperature, humidity and rainfall, while the Caribbean Public Health Agency collects national surveillance data for noncommunicable and communicable diseases, emerging diseases and injuries. The two agencies should strengthen their

collaboration to link climate and health surveillance data. This includes the electronic integration of datasets and incorporating heat thresholds into analyses of health data. High-quality national and regional data are needed to downscale reanalysis of global data (R4ACCHC, 2023a). It is likely that both agencies will need financial and technical resources to boost such collaboration.

National surveillance data need to be collected to capture heat-related illnesses, and research capacity needs to be increased to analyse both climate and environmental data in the context of heat-related illnesses. As part of this research, equipment should be widely deployed to quantify ambient air temperature and humidity (R4ACCHC, 2023a). Furthermore, heat-related illnesses and mortality are underreported around the world generally, so improved training of health professionals in the Caribbean to recognise and document heat-related illnesses and mortality is essential.

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