INSPQ INSTITUT NATIONAL DE SANTÉ PUBLIQUE DU QUÉBEC

Heat adaptation measures

STATE OF KNOWLEDGE

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SUMMARY REPORT

Québec

AUTHORS

Ray Bustinza, Scientific Advisor
David Demers-Bouffard, Scientific Advisor
Direction de la santé environnementale et de la toxicologie

UNDER THE COORDINATION OF

Pierre Gosselin, Medical Consultant
Direction de la santé environnementale et de la toxicologie

UNDER THE SCIENTIFIC DIRECTION OF

Céline Campagna, Scientific Lead
Direction de la santé environnementale et de la toxicologie

REVIEWERS

The INSPQ would like to sincerely thank the following individuals who agreed to provide their time, expertise and comments on this document.

Ministère de la Santé et des Services sociaux
Isabelle Demers, Environmental Health Advisor

Members of the Environmental Health Emergencies Science Team
Lise Laplante, Medical Consultant
Louis-Simon Bolduc, Scientific Advisor

The following individuals only reviewed the sections related to COVID-19:

Geneviève Anctil, Nursing Consultant
Jasmin Villeneuve, Medical Consultant
Direction des risques biologiques et de la santé au travail

Caroline Huot, Medical Specialist
Stéphanie Potvin, Scientific Advisor
Jean-Marc Leclerc, Scientific Advisor
Patrick Poulin, Scientific Advisor
Direction de la santé environnementale et de la toxicologie

The reviewers were asked to comment on the pre-final version of this scientific production and, as a result, did not review or endorse the final content.

LAYOUT

Mélanie Brousseau, Administrative Officer
Direction de la santé environnementale et de la toxicologie

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LISTE OF ABBREVIATIONS AND ACRONYMS

CDC	Centers for Disease Control and Prevention
CNESST	Commission des normes, de l'équité, de la santé et de la sécurité du travail
IPCC	Intergovernmental Panel on Climate Change
INSPQ	Institut national de santé publique du Québec
MSSS	Ministère de la Santé et des Services sociaux
SUPREME	Surveillance and Prevention of the Impacts of Extreme Meteorological Events on Public Health system
TCNSE	Table de concertation nationale en santé environnementale

HIGHLIGHTS

- Average temperatures as well as the intensity and frequency of heat waves will continue to increase due to climate change. This puts public health at risk.
- The purpose of this literature review is to update the information contained in the 2006 Ministère de la Santé et des Services sociaux (MSSS) report on the most relevant and effective measures for adapting to heat. The review made it possible to:
  - Corroborate the relevance of the risk groups targeted by the MSSS and the soundness of adaptation measures to counter the adverse effects of heat on health.
  - Make specific recommendations for risk groups, such as people with limited mobility or limited contact with family or friends.
  - Recommend adding a new risk group: pregnant women and their foetus.
  - Recommend adding details to adaptation measures. For example, during heat events, regularly visit at-risk people. This helps visitors identify signs of heat-related illnesses more quickly than over the telephone.
  - Recommend adding new adaptation measures, such as getting in shape or using an electric fan.
- The results of this review will allow public health authorities, more specifically environmental health professionals from the regional public health departments and the MSSS, to strengthen their capacity for decision-making with respect to heat in order to reduce heat-related morbidity and mortality.

SUMMARY

This literature review, initiated at the request of the Table de concertation nationale en santé environnementale (TCNSE), aims to identify groups at risk during heat events and the adaptation measures proposed by other government agencies and in the scientific literature in order to:

- Recommend, if necessary, the adjustment of risk groups already targeted by the MSSS or the addition of new groups.
- Recommend, if necessary, the adjustment of adaptation measures currently recommended by the MSSS or the addition of new measures.
- Recommend, if necessary, the adjustment of heat adaptation measures in the context of the COVID-19 pandemic.

Identification of at-risk groups

The MSSS regularly identifies people who are at higher risk of developing heat-related complications.[1]

The following are the proposed adaptations or additions.

Proposed adjustments for at-risk groups

Risk group: "People with reduced autonomy or who live alone"

Add details:

- People with reduced mobility.
- People with limited contact with family or friends (e.g., single people).

Risk group: "People who work in hot environments"

Add details:

- Add "agricultural workers" to the wording: People with physically demanding jobs or who work in the sun or outdoors, such as construction workers or **agricultural workers**.

New recommended group

Risk group: "Pregnant women and their foetus"

Add this group to those at risk.

[1] https://www.quebec.ca/en/health/advice-and-prevention/health-and-environment/the-effects-of-oppressive-and-extreme-heat

Adaptation measures

The MSSS regularly reviews its recommendations for adaptation measures that can reduce the population's exposure or sensitivity to heat, intended for the public or health organizations.[2]

The following are the proposed adjustments or additions.

INDIVIDUAL-BASED ADAPTATION MEASURES

Proposed adjustments

Measure "Arrange for visits from loved ones"

Current MSSS wording: "*Stay in touch with your loved ones and do not hesitate to ask family and friends for help*."

Since visitors can better identify signs of heat-related illnesses in person than over the telephone, consider adding the following details:

- For people at risk: arrange for regular visits with loved ones (family, neighbours or friends) during heat waves.
- For the relatives of people at risk: the loved ones of people who are elderly, frail or living alone should visit them regularly during heat waves.

Measure "Wear temperature-appropriate clothing"

Current MSSS wording: "*Wear lightweight clothing*."

Consider adding the following details:

- Wear loose-fitting and light-coloured clothing.
- Wear a wide-brimmed breathable hat.

Measure "Protect children"

Current MSSS wording: "*Protect children from the heat: dress them in light clothing; cover their head with a wide-brimmed hat; never leave them alone in a car.*"

Consider adding the following details:

- Never leave children alone in a parked car, even if the windows are cracked open.
- Make sure everyone is out of the car before leaving the parked car.

[2] https://www.quebec.ca/en/health/advice-and-prevention/health-and-environment/preventing-the-effects-of-oppressive-and-extreme-heat

- Use a stuffed animal as a reminder that there is a child in the car: always keep a stuffed animal in the child's seat and, when the child is in the seat, place the stuffed animal in the seat next to the driver.

Measure "Lower the indoor temperature by natural means"

Current MSSS wording: "*Close the curtains or blinds when the sun is out.*"

Consider adding the following details:

- During the day, close windows, curtains, blinds or shutters in rooms that face the sun to prevent sunlight and heat from entering.
- At night, if the outside temperature is lower than the inside temperature, open the windows to ventilate the house with cooler air from outside.
- Preferably, prepare meals that do not need to be cooked to avoid the heat generated by heating elements.
- Keep interior lights in your home off or dimmed. Minimize your use of heat-producing appliances (e.g., televisions, dryer).
- Stay on the lower floors, if applicable.
- If you live in a house, plant large trees on the side where the sun hits the house during the hottest part of the day.

Measure "Cool down your skin"

Current MSSS wording: "*Cool your skin with a wet towel several times a day.*"

Consider adding the following details:

- Wet your skin regularly by placing, for example, a cool wet cloth on your face, arms and neck, and by spraying cold water on your face.

Measure "Reduce physical exertion"

Current MSSS wording: "*Reduce physical exertion*."

Consider adding the following details:

- Stay adequately hydrated.
- Schedule exercise for the cooler parts of the day (e.g., before 11 a.m. or after 4 p.m.).
- Workers: Inform workers about the effects of heat on their health so that they can recognize them and know how to prevent them. Follow the recommendations of the Commission des normes de l'équité de la santé et de la sécurité du travail (CNESST).[3]

[3] https://www.cnesst.gouv.qc.ca/sites/default/files/publications/travailler-a-la-chaleur.pdf

- Employers: Employers, supervisors and forepersons need to have a good understanding of heat-related health impacts in order to design prevention measures suited to local conditions.

Measure "Monitor heat-related symptoms"

Current MSSS wording: "*It is important to monitor any deterioration in the health of an adult who has the following symptoms:*"

Consider adding the following symptoms to the list:

- Nausea or vomiting.
- Drowsiness or temper tantrums among children
- If you experience any of these symptoms, immediately go to a cool place and drink water.
- If someone else is experiencing these symptoms, cool them immediately as you wait for help:
  - move them to a cool place if possible;
  - apply cold water to large areas of their skin or clothing;
  - fan the person as much as possible.

New proposed measures

Consider these wordings:

Measure "Get in shape"

- Prepare for the heat: get in shape to reduce the risks.

Measure "Take medication"

- Consult your doctor, pharmacist or clinical nurse to adjust, if necessary, the doses of certain medications taken on a regular basis.

Measure "Monitor weather conditions"

- Stay tuned to local weather forecasts and alerts to know when to take extra precautions.

Measure "Use an electric fan"

- People under age 65: If the indoor temperature in your home is below 36 °C, use an electric fan, aim the air flow in your direction and drink plenty of fluids (especially water) before you feel thirsty. If the temperature is above 36 °C, avoid using an electric fan, as this can increase body temperature even more.

Measure "Go to a pool"

- Spend a few hours in a pool.

Measure "Go to a park"

- Spend a few hours in a cool place, such as an area shaded by trees.

POPULATION-BASED ADAPTATION MEASURES

Important aspects to consider or strengthen

Consider adding the following details.

Measure "Implement a response plan"

- Mobilization of partners. To prepare the community for the upcoming warm season by identifying its needs, recruiting stakeholders and developing implementation plans.
- A community response plan. To encourage individual heat protection initiatives by promoting interventions for those at risk.
- A communication and outreach plan, which uses press releases, interviews, and websites, to promote awareness of heat-related health effects, provide advice to reduce health risks through public education on prevention measures and provide information on available services and resources.
- An evaluation plan. To evaluate the timeliness, relevance and effectiveness of the measures implemented and their alignment with priorities and contribution to reducing health impacts.
- A warning system. To alert stakeholders, government officials or the public, who can then take predetermined health protection measures.
- Anticipate certain regulations being adapted in the context of the COVID-19 pandemic.

Measure "Setting up an early warning system: SUPREME"

- Regular performance evaluations of its ability to predict heat waves.
- Regular updates of the heat thresholds used to launch warnings.

Measure "Setting up an automated telephone alert system: ATAS"

- Consider implementing such a system for certain high-risk populations.
- Assessment of ability to elicit preventive behaviours.

Measure "Implementing a mapping application: public health geoportal"

- Include an indicator of heat wave vulnerability.

STRUCTURAL ADAPTATION MEASURES

New proposed measures

Consider these wordings.

Measure "Greening cities"

- Promote and support urban greening projects and regulatory measures that contribute to increased canopy, especially for the health network.

Measure "Increase the albedo of surfaces"

- Promote and support projects and regulatory measures to increase the albedo of urban environments, especially for the health network.

Measure "Improve access to public pools"

- Extend the opening hours of public pools during heat events.

Measure "Improve access to air-conditioned public spaces"

- Make these places available during times of the day when indoor temperatures are typically the warmest, from roughly noon to 9 p.m.
- Be available in priority areas, i.e., areas with the following:
  - low level of air conditioning use;
  - high density of older adults or people with chronic illnesses;
  - in the centre of urban heat islands;
  - a high number of dwellings requiring major repairs.
- Ensure the continuity of the electrical grid. The electrical grid may become overloaded as a result of a significant increase in energy demand, which can cause power outages that make it impossible to use air conditioners. To prevent this situation, access to a backup generator or a high-capacity battery may become essential.
- Distribute air conditioners or provide financial assistance to purchase them. Those at particularly high risk, such as the elderly, who do not have access to air conditioning, either for a physical (e.g., reduced mobility) or financial (e.g., low income) reason, could be eligible for a free distribution of air-conditioning units or government financial assistance to purchase one.
- Financial support for hydro bills. People who already own an air conditioner but cannot use it because of the high cost of operating it could be eligible to receive government financial assistance to pay their hydro bills and make it more affordable to use their air conditioners.

MSSS adaptation measures in the context of the COVID-19 pandemic

This review also identified heat adaptation measures in the context of the COVID-19 pandemic that could be adjusted or added to avoid increasing the risk of infection.

Proposed adjustments

Measure "Regarding air-conditioned public spaces"

Current MSSS wording: *If you are in an air-conditioned public space, respect the two-metre physical distance and follow the health guidelines*.

Consider adding the following details:

Individual-based measure:

- Do not use public places if you are experiencing symptoms consistent with COVID-19, if you are waiting for a test or test result, or if you are required to be in preventive isolation.
- Follow the basic health guidelines in place for the COVID-19 pandemic, such as physical distancing and wearing a mask or face covering.

Structural measures:

- Post and enforce the current COVID-19 pandemic measures, i.e., those for the use of public places by people who are infected, have consistent symptoms or are in preventive isolation, as well as those for physical distancing and for wearing masks and face coverings.
- Enforce indoor control measures, including ventilation and surface cleaning.
- Provide air-conditioned rooms. Rooms in hotels that are closed or less busy as a result of the COVID-19 pandemic may be provided to accommodate people during heat events. In addition, arrangements could be made to drive vulnerable people to these air-conditioned rooms using safe adapted transportation that comply with prevention measures.
- Use air-conditioned buses. These buses must have sufficient natural or mechanical ventilation. It is also recommended that users follow prevention and control measures such as wearing masks and practising hand hygiene. As an alternative, air-conditioned public transit buses could also be used.
- Improve access to air conditioners. Whether they are purchased through financial assistance or distributed for free, improved access would be beneficial for people at risk who are experiencing symptoms consistent with COVID-19, who are waiting for testing or test results or who are in preventive isolation, and who, as a result, would not be able to use air-conditioned places because of the public health measures in place.

NEW PROPOSED MEASURES

Consider these wordings.

Measure "Regarding public pools"

Individual-based measure:

- Do not use public pools if you are experiencing symptoms consistent with COVID-19, if you are waiting for a test or test result or if you are required to self-isolate at home.
- Follow the basic health guidelines in place for the COVID-19 pandemic, such as physical distancing and wearing a mask or face covering.

Structural measure:

- Limit the number of users so it is easier to maintain physical distancing and comply with hygiene instructions.

Measure "Regarding public parks"

Individual-based measures:

- Do not use public parks if you are experiencing symptoms consistent with COVID-19, if you are waiting for a test or test result, or if you are required to self-isolate at home.
- Follow the basic health guidelines in place for the COVID-19 pandemic, such as physical distancing and wearing a mask or face covering.

Structural measures:

  - Improve access to public parks.
  - Clean frequently touched public amenities.
  - Clearly indicate hygiene, physical distancing and usage instructions.
  - Provide access to public restrooms.
  - Redesign facilities, such as making wider paths, increasing rest areas or closing off cramped areas.

Measure "Regarding electric fans and air conditioners"

Individual-based measures in the home of a person who is infected, who has consistent symptoms or who is in preventive isolation:

- The person must reside alone in their home or remain isolated in a room.
- Ensure that the place is well ventilated by properly using continuous mechanical ventilation, if available, or by opening windows, if possible. If windows are opened, they should be opened at least three times a day for a minimum of 15 minutes, while keeping the door to the room closed.

- Ensure that frequently touched surfaces of the electric fan or air conditioner are cleaned and disinfected at least once a day.

  If the person does not live alone, add these measures:

  - Turn off the oscillation mode to avoid potential radial or uncontrolled dispersion of infectious droplets or aerosols.[4]
  - Ensure that the airflow is not being directed toward the room's exit door to prevent infectious droplets or aerosols from being dispersed out of the room.
  - The airflow must be directed far from the person's face.

Relevance of MSSS risk groups and adaptation measures

Finally, this review also assessed the soundness of MSSS risk groups and adaptation measures to reduce the exposure or sensitivity of the public to heat.

Relevance of the risk groups targeted by the MSSS

According to this literature review, all of the heat risk groups already targeted by the MSSS are still highly relevant. They are similar to the groups reported by the other government agencies reviewed and respond to the most current scientific knowledge regarding people's vulnerability to heat. However, this review recommended adding a risk group: pregnant women and their foetus.

Relevance of MSSS adaptation measures

The MSSS-recommended adaptation measures to reduce the public's exposure or sensitivity to heat all remain highly relevant based on the results of this literature review. However, it should be noted that, although the scientific basis for these measures is sound, very few studies have assessed the impact of these measures on reducing the health risk associated with heat events. This review also identified potential improvements to some of the MSSS measures to reduce health risks.

[4] Aerosols: microscopic drops of less than 5 microns in diameter that remain suspended for a long time (from several minutes to several hours).

1 BACKGROUND

Due to climate change, extreme heat events are expected to increase in intensity and frequency in the coming years across all of Canada (Ouranos, 2015). Since the 1990s, the average temperature in Québec has gone up by 1°C, however, it is expected to increase even more significantly, by 3 to 4°C, by 2050 (Ouranos, 2015; RegionsAdapt, 2018). The fight against climate change has two components to reduce its effects on the public. The first component involves reducing greenhouse gas emissions. Although this is a definitive solution, the noticeable benefits are not expected to be seen for few decades. The second component addresses the implementation of adaptation measures, which would, in contrast, reduce negative impacts relatively quickly in most cases (Ouranos, 2015). A climate change adaptation action refers to any process adjusting the current or expected climate and its effects (Field et al., 2014).

In 2006, the *Guide d'intervention : chaleur accablante, volet santé publique* (Laplante and Roman, 2006) of the Comité chaleur accablante of the Table de concertation nationale en santé environnementale (TCNSE) of the Ministère de la Santé et des Services sociaux (MSSS) identified the risk groups and recommended several adaptation measures against extreme heat. Since then, the MSSS regularly reviews its recommendations, based on the latest scientific knowledge, to adapt to extreme heat (Government of Québec, 2020; MSSS, 2020), as well as the identification of people who are more at risk of developing heat-related complications (Government of Québec, 2020; MSSS, 2020).

As part of this review, the TCNSE asked the Institut national de santé publique du Québec (INSPQ) to:

1. Review the risk groups and adaptation measures that can help reduce the public's exposure or sensitivity to heat that are identified in the heat response plans of different organizations around the world.
2. Review the scientific basis for the relevance of these risk groups and adaptation measures.

Because this review was written during the COVID-19 pandemic, the authors decided to also consider the need to adjust adaptation measures that may help reduce the public's exposure or sensitivity to heat while considering public health guidance related to the COVID-19 pandemic.

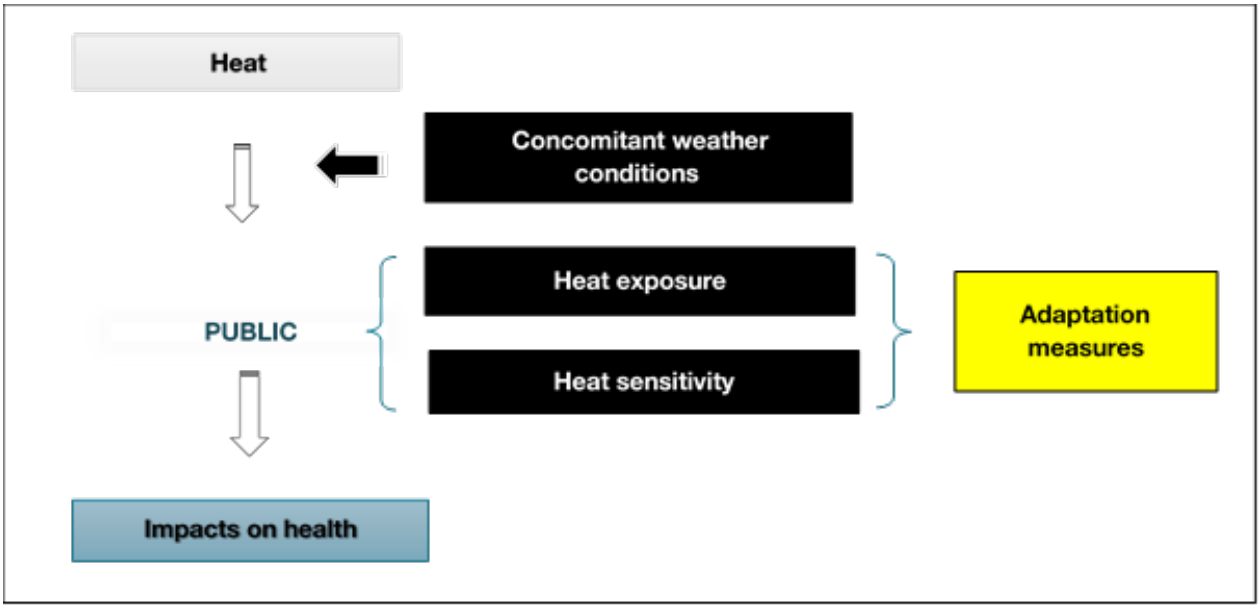
This review is organized into eight chapters:

- Chapter 1: Conceptual framework
- Chapter 2: Methodology
- Chapter 3: Overview of at-risk populations
- Chapter 4: Individual-based heat adaptation measures
- Chapter 5: Population-based heat adaptation measures
- Chapter 6: Structural heat adaptation measures
- Chapter 7: Heat adaptation measures in the context of the COVID-19 pandemic
- Chapter 8: Conclusions and recommendations

2 CONCEPTUAL FRAMEWORK

In the scientific literature, several factors are reported to modulate the impacts of heat on human health. The conceptual framework presented below (Figure 1), inspired by Kovats and Hajat (2008), illustrates these factors: the characteristics of the heat event, the concomitant weather conditions, the population's exposure to heat, the population's sensitivity to heat and the adaptation measures taken.

Figure 1 Conceptual framework on factors that may modulate heat impacts



Source: adapted from Kovats and Hajat (2008).

The purpose of this review is to analyze adaptation measures to reduce the public's exposure or sensitivity to heat. The definition of *adaptation measures* used in this review was adapted from the Intergovernmental Panel on Climate Change (IPCC) definition (Field et al., 2014): an adaptation measure is an approach to adjust to the current or expected climate in order to mitigate detrimental effects and exploit beneficial effects. For the purposes of this publication, the adaptation measures considered are measures that can reduce the public's exposure or sensitivity to heat.

Based on the operational definitions proposed by the Observatoire québécois de l'adaptation aux changements climatiques (Sovacool et al., 2015; Valois et al., 2017a), adaptation measures in this review have been classified into individual-based measures, population-based measures and structural measures.

- **Individual-based measures:** measures that any individual can implement themselves to reduce the effects of heat. For example, drinking water, wearing certain clothing.

- **Population-based measures:** measures implemented by organizations to improve the adaptive capacity of populations without requiring changes to the built or natural environment. They may include warning systems or response plans. Because they are population-based and long-term, they can have a significant beneficial impact.
- **Structural measures:** measures to mitigate the effects of natural hazards that involves making changes to the built or natural environment on a scale other than individual. They may include greening the environment and improving access to air conditioning. They also aim to improve the adaptive capacity of populations in the long term.

3 METHODOLOGY

3.1 Scope

This study analyzes the scientific information available between 2010 and 2020 covering adaptation measures that can help reduce the public's exposure or sensitivity to heat proposed by some organizations or evaluated by scientific studies.

The adaptation measures recommended in this review are generally adequate for the entire population. When the measures under consideration are specific to a particular group, this specificity is noted in the recommendation.

3.2 Objectives

The INSPQ conducted a review of the literature on risk groups and adaptation measures that can help reduce the public's exposure or sensitivity to heat by analyzing recommendations from other government agencies to:

- Recommend, if necessary, the adjustment of risk groups targeted by the MSSS or the addition of new groups.
- Recommend, if necessary, the adjustment of MSSS adaptation measures or the addition of new measures.
- Identify studies that assess different adaptation measures that can help reduce the public's exposure or sensitivity to heat.
- Recommend, if necessary, the adjustment of MSSS adaptation measures in the context of the COVID-19 pandemic.

3.3 Publication selection

An unsystematic review of the grey literature regarding adaptation measures that can help reduce the public's exposure or sensitivity to heat proposed by different organizations was conducted on Google. For this research, the combination of the following terms (in English and French) was used: heat, heat wave, adaptation measures, prevention measures, surveillance and health impacts. The sites of five government agencies were specifically reviewed:

- Health Canada: https://www.canada.ca/en/health-canada/services/climate-change-health/extreme-heat.html.
- Ontario Ministry of Health: http://www.health.gov.on.ca/en/public/programs/emu/emerg_prep/et_heat.aspx.
- U.S. Centers for Disease Control and Prevention: https://www.cdc.gov/disasters/extremeheat/heattips.html.

- The UK National Health Service: https://www.nhs.uk/live-well/healthy-body/heatwave-how-to-cope-in-hot-weather/.
- Santé publique France: https://www.santepubliquefrance.fr/determinants-de-sante/climat/fortes-chaleurs-canicule/articles/quelles-mesures-pour-prevenir-les-risques-lies-a-la-chaleur.

In a second step, in the summer of 2020, another non-systematic search was performed, covering the period from 2010 to 2019, on Medline and Google Scholar. The objective of this search was to identify studies on the evaluation of different proposed heat adaptation measures. The search focused particularly, but not exclusively, on articles for studies conducted in North America and Europe. The search included original articles, but more importantly, meta-analyses and systematic reviews. In addition, articles cited in the identified publications were also identified. For this research, the following combination of terms (in English and French) was used: assessment, heat, heat wave, adaptation measures, prevention measures.

3.4 External review

The text of this review was also reviewed by several actors outside the project to assess the methodological, scientific and communication qualities of the document. The reviewers were asked to comment on the pre-final version, and, as a result, they did not review or endorse the final content. The reviewers used the INSPQ Institutional Review Grid to review the document. Their comments have been incorporated into a table indicating whether the comments were retained, the reasons, and how they were addressed in the final version. Some references have been added to this review as a result of the comments, in addition to those identified in the literature review.

4 OVERVIEW OF POPULATIONS AT RISK

The risk of experiencing heat wave-related discomfort increases (Bustinza and Demers-Bouffard, 2019; Government of Québec, 2020) when:

- humidity is high;
- the wind is not strong;
- the hot spell occurs early or late in the season when the body is not or no longer accustomed to the heat;
- the heat period lasts several days;

However, in addition to weather factors, individual characteristics also play a major role as a risk factor. The health impacts of hot weather can vary depending on individual clinical and physiological characteristics, such as age, gender, presence of pre-existing morbidity, or use of certain medications, but also depending on characteristics of the living environment that impact heat exposure, such as housing, income, work activities, or social isolation (Bustinza and Demers-Bouffard, 2019; WHO, 2015).

The risk groups evaluated in this review, in no particular order, are:

- Section 4.1: Seniors
- Section 4.2: Infants and young children
- Section 4.3: Pregnant women
- Section 4.4: Men
- Section 4.5: People with chronic conditions
- Section 4.6: People taking certain medications
- Section 4.7: People with reduced autonomy or who live alone
- Section 4.8: People with limited access to cool or air-conditioned places
- Section 4.9: People with drug or alcohol use issues
- Section 4.10: People who work in high-temperature environments
- Section 4.11: People who are in poor physical condition or who are overweight
- Section 4.12: Visible minorities
- Section 4.13: People who exercise intensely

4.1 Seniors

All of the government agency sites reviewed identify older adults (the definition of which varies by agency, but generally those 65 years and older) as a group particularly at risk to heat (CDC, 2017b; Government of Canada, 2020; Ontario - Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020).

Theoretically, the elderly would be more at risk of experiencing the impacts of heat, because they have, compared with younger people, a lower capacity for physical adaptation, they adopt fewer preventive behaviours and they display a higher level of social isolation and dependence (Bélanger, Gosselin, et al. 2015; Hattis et al., 2012; Laverdière et al., 2015; Laverdière et al., 2016; Valois et al., 2016). However, studies that compare heat-related health risks between older and younger adults are very limited, making it unclear whether older people have greater risks. A meta-analysis, the only publication found that compares older people with younger groups, notes that the risk of heat-related death is 2% significantly higher for people aged 65 years and older than for people aged 15 to 64 years (Benmarhnia et al., 2015).

In Québec, the results of studies on age as a risk factor were not conclusive. In a study of health impacts during the 2010 and 2011 heat waves, the average age of those who died during the heat waves was not statistically different from the comparison periods in 16 of the 18 heat spells studied (Lebel et al., 2015). However, older adults, because of their lower capacity for physical adaptation to heat and a higher level of social isolation and dependence, and because they live in a greater proportion of poorly adapted housing, would be at greater risk of experiencing the effects of heat (Bélanger, Gosselin, et al., 2015). In addition, older adults generally do not perceive themselves to be at risk, a belief that decreases their predisposition to consciously engage in preventive behaviours (Valois et al., 2018). Given their limited mobility compared with younger people, older people may also be less exposed to heat because they leave their homes less, especially if their homes are well insulated, ventilated or air-conditioned. The Public Health GeoPortal[5] allows you to locate these populations by age group based on proportion or number per dissemination area.

4.2 Infants and young children

All government agencies consulted consider infants (under one year old) and young children (ranging from less than 4 years to less than 6 years, depending on the study) as a group particularly at risk to heat (CDC, 2017b; Government of Canada, 2020; Ontario - Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020).

Infants and young children are often identified as at-risk populations in the scientific literature, although conclusive studies are rarer than those on older adults (Vanos, 2015). A systematic review reported that mortality during extreme heat is significantly higher in children aged 0 to

[5] INSPQ Public Health GeoPortal: https://www.inspq.rtss.qc.ca/geo/portail/index.php. This site is accessible only to personnel of the health and social services network.

4 years than in children aged 5 to 14 years (Xu et al., 2012). In Québec, the association between sudden death in 3-to-9-month-olds at temperatures above 29 °C compared with 20 °C is significantly greater (OR:[6] 3.9, 95% CI 1.8–8.1) (Auger et al., 2015). The Public Health GeoPortal allows you to locate this population by proportion or number by dissemination area.

4.3 Pregnant women and their foetus

Only Santé publique France considers pregnant women to be a group at risk to heat (Santé publique France, 2019).

A study in Québec suggests that a woman exposed to high heat whose pregnancy is near or at term has a significantly elevated risk (RR: 1.12) of placental abruption, which can be fatal for both her and the foetus (He et al., 2018).

In addition, several other complications, mostly affecting the foetus, have been associated with heat. These include prematurity (Auger et al., 2014) and congenital complications such as heart or neural tube defects (Auger, Fraser, Arbour, et al., 2017; Auger, Fraser, Sauve, et al., 2017).

Two recent systematic reviews confirmed the association between heat exposure of pregnant women and risks to the foetus (Chersich et al., 2020; Kuehn and McCormick, 2017). One review reported that extremely hot temperatures can negatively impact gestation length, birth weight, stillbirth, and neonatal stress (Kuehn and McCormick, 2017). As well, it seems that the intensity of the heat would be more important than the duration of the exposure. The other systematic review and meta-analysis reported a significant increase in the possibility of prematurity (OR: 1.16, 95% CI 1.10–1.23) during extreme heat waves (Chersich et al., 2020). In the same study, a 1 °C increase significantly increased the possibility of prematurity (OR: 1.05, 95% CI 1.03–1.07) and stillbirth (OR: 1.05, 95% CI 1.01–1.08).

This population was previously identified as a heat risk population in a recent INSPQ publication (Bustinza and Demers-Bouffard, 2019).

4.4 Men

None of the government agencies considers men to be a heat risk group.

A few studies consider men to be higher risk groups for heat effects than women for certain conditions, such as renal colic, ischemic heart disease, and all-cause hospitalizations (Bayentin et al., 2010; Ordon et al., 2016; Schmeltz et al., 2015). However, a meta-analysis indicated that the risk of heat-related death is not significantly different between women and men (Benmarhnia et al., 2015). In Vancouver, the risk of death for men during a heat wave in 2009 was not significantly different from that of women (Kosatsky et al., 2012).

[6] OR: Odds Ratio. This is a statistical measure that assesses the likelihood of an event occurring in an exposed group compared with an unexposed group.

4.5 People with chronic conditions

Four of the five government agencies consulted consider people with chronic conditions (e.g., respiratory diseases, cardiovascular diseases, diabetes) as a group at risk to heat (CDC, 2017b; Government of Canada, 2020; Ontario - Ministry of Health, 2015; United Kingdom National Health Service, 2020).

People with pre-existing chronic morbidities are more sensitive to heat (Bustinza and Demers-Bouffard, 2019; CDC, 2017a). Several indicators of co-morbidity have been listed during extreme heat: diabetes, cardiovascular issues, respiratory diseases, cancer (Lavigne et al., 2014). In Québec, people with two or more chronic conditions are 4 to 6 times more likely to report heat-related health problems compared with people with none (Bélanger et al., 2014).

In addition, older adults are at greater risk for having multiple chronic diseases. It is estimated that approximately 70% of people aged 65 and older in southern Québec have at least one chronic heat-sensitizing illness (Laverdière et al., 2015). The Public Health GeoPortal allows you to locate people with chronic conditions by density level and by dissemination area.

4.6 People taking certain medications

Three of the five agencies consulted consider people who take certain medications, especially prescription drugs, to be at risk during hot weather (CDC, 2017b; Ontario - Ministry of Health, 2015; Santé publique France, 2019). Santé publique France advises:

- Do not hesitate to ask your doctor or pharmacist for advice, especially if you have a health problem or if you are currently taking medication (e.g., dose adjustments).
- Taking certain medications can increase an individual's susceptibility to extreme heat by accelerating dehydration and body heat production. The risks may be related to the drug or to its adverse effects. For example, diuretics, immunosuppressants, interferons and anticoagulants have the potential to increase the risk of hyperthermia (Bélanger, Bustinza, et al., 2015). As for antidepressants, antipsychotics, antihistamines, neuroleptics, and diuretics, some may predispose people who use them to heat stroke or heat stress in hot weather (WHO, 2015). Detailed reports regarding the link between drugs and heat have been published by the INSPQ (Blachère and Perreault, 2010, 2012a, 2012b, 2013), a synthesis document is also available (Bélanger, Bustinza, et al., 2015).
- The authors of a recent American study found that, in people aged 64 years and older with chronic conditions, such as diabetes, dementia, and cardiovascular, pulmonary or renal disease, during extreme heat waves (2 days with temperatures above the 95th percentile) the risk of hospitalization increases between 21% (95% CI: 7%–38%) and 33% (95% CI: 14%–55%) depending on the class of medication taken (Layton et al., 2020).

4.7 People with reduced autonomy or who live alone

Only two of the five agencies consulted reported people with reduced autonomy or who live alone as being at risk during hot weather (Ontario - Ministry of Health, 2015; United Kingdom National Health Service, 2020).

A Canadian study showed a significant increase in the risk of health impacts in people aged 60 and over with impaired mobility during heat waves (Kenny et al., 2010). In a study covering the period from 2006 to 2010, it was estimated that seniors with significant physical disabilities[7] who were living in southern Québec were, compared with seniors without disabilities, 2.5 times more likely to be admitted to the emergency department, and 2.7 times more likely to be physically harmed by heat (Laverdière et al., 2016). It should be considered that reduced autonomy can be correlated with social isolation. Social isolation would be an indicator of difficulty in taking action to protect oneself from the heat. Social isolation can encompass several concepts: being single or living alone, having limited (less than once a month) contact (in person, by phone call, or in writing), with one's children, family or friends, and not participating in social organizations such as clubs or religious groups (Smith et al., 2018). A study in England concluded that people with psychotic disorders or dementia have a higher risk of dying at temperatures above the 93rd percentile of the annual temperature distribution, which may be due to their social isolation and inability to cope with heat exposure (Page et al., 2012), as well as certain behaviours (e.g., clothing) or symptoms (e.g., paranoia) related to the illness (Vida, 2011).

4.8 People with limited access to cool or air-conditioned places

Three of the five agencies consulted considered people with factors related to limited access to cool or air-conditioned places as groups at risk to heat (Government of Canada, 2020; Ontario - Ministry of Health, 2015; United Kingdom National Health Service, 2020).

Several factors can have a significant impact on people's access to cool or air-conditioned places, and many of these factors are often correlated with each other: being materially disadvantaged, living in an area with a high population density, living in heat islands, or living in poorly adapted housing (Bustinza and Demers-Bouffard, 2019). The Public Health GeoPortal allows the location of populations by dissemination area based on all these factors and by the level of access to air-conditioned locations.

4.8.1 Materially disadvantaged persons

Québec regions with a high level of material and social deprivation had a higher rate of hospitalization for ischemic heart disease than more advantaged regions during extreme heat events from 1989 to 2006 (Bayentin et al., 2010). In addition, one survey found that Québeckers in the lowest income quintile are 20% more likely to seek medical attention during extreme heat than those in the highest income quintile because they experience more health consequences

[7] Need help with daily household tasks or stay in bed for health reasons.

(Bélanger et al., 2014). However, in Québec, for the 2010 and 2011 heat waves, no statistically significant differences were observed between the risk of death in disadvantaged and very disadvantaged (materially) dissemination areas and other dissemination areas (Lebel et al., 2015). However, this may be a lack of statistical strength given the low numbers of deaths. Lastly, a meta-analysis, unrestricted for geographic location, demonstrated that the risk of heat-related death was not significantly different between people living in areas considered disadvantaged or advantaged (Benmarhnia et al., 2015). The Public Health GeoPortal allows you to locate this population by level of favourability by dissemination area.

4.8.2 People living in urban heat islands

A heat island is a phenomenon where the ambient temperature in an urban area is higher than in the surrounding areas. Thus, it can exacerbate the health impacts of heat waves (Dousset et al., 2011). In Toronto, one study suggested that changing canopy coverage from less than 5% to more than 5% can reduce ambulance calls by 80% (Graham et al., 2016). In Montréal, it has been reported that the risk of death in heat islands during a heat wave is greater (around 25%) than in non-heat island areas (Smargiassi et al., 2009). Mapping intra-urban heat islands as a monitoring indicator can help better understand the risks associated with heat waves, and better anticipate and manage their health impacts, thereby contributing to the development of more targeted adaptation strategies (Dousset et al., 2011). The Public Health GeoPortal allows you to locate heat islands.

4.8.3 People without access to an air conditioner

Air conditioning appears to be a good way to reduce exposure to indoor heat during heat waves (Bustinza and Demers-Bouffard, 2019; Ostro et al., 2010). A study in 211 U.S. cities reported that the risk of heat-related death is modulated by outdoor temperature and air conditioner use (Nordio et al., 2015). In Québec, in 2015, the proportion of households with one of the different types of air conditioners was 53%, with large regional variations ranging from 39% in Saguenay to 75% in the Outaouais (Statistics Canada, 2019). The Public Health GeoPortal allows you to locate areas of diffusion based on the level of air conditioner use.

4.8.4 People living in housing in need of major repairs

A study in 109 U.S. cities compared periods with heat waves and periods without heat waves. The study found that the increase in the percentage of hospitalizations among people 65 years and older for heat-related illnesses is significantly greater (15%) in areas with a high percentage of homes built before 1940 than in areas with a lower percentage (9%) (Gronlund et al., 2016). The Public Health GeoPortal allows for the location of dissemination areas based on the number or percentage of dwellings in need of major repair.[8]

[8] It should be noted that the need for major repairs in both cases (U.S. study and GeoPortal data) is based only on the year of construction of the houses and not on a precise measure of that need.

4.9 People with drug or alcohol use issues

None of the agencies consulted identified people with substance abuse problems as a risk group.

In Québec, one study indicated that the risk of cocaine overdose increases as the maximum summer temperature increases, but that this risk for all drugs is not significant (Auger, Bilodeau-Bertrand, Labesse, et al., 2017). It has been suggested that there are social factors, such as social isolation, but also biological factors, such as psychomotor restlessness or poor physical condition, which increase the risk of mortality in drug users (Page et al., 2012). For others, people with substance abuse problems should be identified as a population at risk during heat waves (Hayes and Poland, 2018), and they should also be considered a population that lacks the ability or resources to protect themselves (Cusack et al., 2011).

4.10 People who work in high-temperature environments

All government agencies consulted considered people who work in high temperature environments (e.g., agricultural, construction workers) as a group particularly at risk to heat (CDC, 2017b; Government of Canada, 2020; Ontario - Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020).

In Ontario, from 2004 to 2010, each degree above 22°C increased the median number of emergency room admissions for work-related heat illness and discomfort by 75% (Fortune et al., 2014). In Québec, one study reported that daily compensation for accidents among forestry workers increases by 1.1% for every 1°C rise in daily maximum temperature (Adam-Poupart et al., 2015). Another study in Québec indicated that each one-degree increase above the optimal temperature increases the number of claims for heat-related illnesses or disease by 42% (Adam-Poupart et al., 2014).

4.11 People who are in poor physical condition or who are overweight

Only the CDC considered overweight individuals to be a heat risk group (CDC, 2017b).

When physical fitness is inadequate, the cardiovascular system is placed under significant stress, even for low-demand activities, reducing cardiovascular reserve and heat tolerance (Bustinza and Demers-Bouffard, 2019). Indeed, cardiovascular reserve is important for thermoregulation, since it allows for the dissipation of body heat by transferring heat to the skin through the bloodstream (World Health Organization, 2018). Being overweight is another indicator that increases heat sensitivity (Bustinza & Demers-Bouffard, 2019; CDC, 2017a). Overweight people are more sensitive to heat since they have more subcutaneous tissue, and therefore a higher heart rate is required to be able to dissipate heat (World Health Organization, 2018). In Québec, one study, in people aged 68–82 years, considered obesity as one of the chronic conditions making people in this group more sensitive to heat (Laverdière et al., 2015).

4.12 Visible minorities

None of the agencies consulted identified visible minorities as a risk group.

A review of the literature presents mixed results regarding the relationship between heat and mortality among racial minorities (Gronlund, 2014). Structural (low income, residence in a heat island, etc.) or cultural (linguistic and social isolation, perception of risk, etc.) rather than genetic indicators would be involved.

4.13 People who exercise intensely

All government agencies consulted considered people who exercise intensely during heat waves as a particularly high-risk group (CDC, 2017b; Government of Canada, 2020; Ontario - Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020).

Exercising in hot weather places additional stress on the body (Macartney et al., 2020; Mayo Clinic Staff, 2020). Exercise can lead to a body heat production that is 10 times greater compared with a being at rest (Leyk et al., 2019). To help cool down, the body sends more blood to circulate through the skin. This leaves less blood for the muscles, which increases the heart rate, which then further increases the body temperature. Stress can be particularly significant when exercise is prolonged for 30 minutes or longer (Macartney et al., 2020).

5 INDIVIDUAL-BASED ADAPTATION MEASURES

Individual coping measures are those that can be taken by individuals. They are usually temporary and allow a punctual reduction of heat exposure, such as taking showers or spending time in an air-conditioned place. These measures can also lead to a reduction in heat sensitivity, for example, getting in shape or adjusting the intake of regular medications. They are usually recommended by organizations and require specific behaviour from individuals.

The structural adaptation measures evaluated in this review, in no particular order, are:

- Section 5.1: Arrange for visits from your loved ones
- Section 5.2: Get in shape
- Section 5.3: Monitor the weather
- Section 5.4: Hydrate
- Section 5.5: Wear appropriate clothing for the temperature
- Section 5.6: Protect children
- Section 5.7: Keep the home cool
- Section 5.8: Cool off with water
- Section 5.9: Move to a shaded or cool area
- Section 5.10: Reduce physical exertion
- Section 5.11: Avoid alcoholic beverages
- Section 5.12: Monitor for heat-related symptoms

5.1 Arrange for visits from your loved ones

One of the precautions that people at risk—especially seniors, those with reduced autonomy or those living alone—can take to prepare for hot weather to protect their health is to schedule visits from loved ones or to check in with loved ones.

All five agencies consulted (CDC, 2017b; Government of Canada, 2020; Ontario – Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020) recommend limiting or avoiding physical exertion. For example, the Government of Canada makes the following recommendation for preparing for a hot spell:

- Schedule regular visits from family members, neighbours or friends on very hot days in case you need help. Visitors can spot signs of heat-related illness that might go unnoticed over the phone.

5.2 Get in shape

Since people who are not fit or overweight would be a group at risk for health impacts during hot weather (Bustinza & Demers-Bouffard, 2019), getting fit is one way to prepare for the heat ahead of time. However, none of the agencies consulted made recommendations in this regard, perhaps because they are not heat-specific.

An individual measure to consider would be:

- Prepare for the heat: getting in shape helps reduce health risks.

The help of certain professionals (nutritionists or psychologists) could facilitate this process.

5.3 Monitor the weather

Three of the five agencies (CDC, 2017b; Government of Canada, 2020; Ontario - Ministry of Health, 2015) recommended monitoring the weather to be aware of a potential heat spell. For example, the Government of Canada recommends:

- Stay tuned to local weather forecasts and alerts, so that you will know when to take extra precautions.

5.4 Hydrate

All five agencies consulted (CDC, 2017b; Government of Canada, 2020; Ontario – Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020) recommended hydrating during a heat spell. For example, the Government of Canada recommends:

- Drink plenty of fluids (especially water) before you feel thirsty to reduce your risk of dehydration. Thirst is not a good indicator of dehydration.

Only Santé publique France gives specific recommendations for seniors and children:

- Seniors: Drink about 1.5 litres of water, which is the amount of water you are able to eliminate.
- Infants and young children: Regularly offer them something to drink.

No studies were identified in this review of the scientific literature linking adequate hydration in hot weather to reduced heat-related health risks. However, it is known that dehydration has a significant impact on health during heat waves. Indeed, a large proportion of deaths during the 2003 heat wave in France were due to heat stroke associated with and fostered by dehydration (Swynghedauw et al., 2012).

5.5 Wear appropriate clothing for the temperature

Four of the five agencies consulted (CDC, 2017b; Government of Canada, 2020; Ontario - Ministry of Health, 2015; United Kingdom National Health Service, 2020) recommended wearing light clothing during heat spells. For example, the Government of Canada recommends:

- Wear loose-fitting, light-coloured clothing and a wide-brimmed hat made of material that allows air to circulate.

Given their insulating properties, clothing generally reduces the body's most effective physiological means of cooling itself: evaporation of perspiration (Leyk et al., 2019), making it important to wear lightweight clothing during hot weather.

5.6 Protect children

Three of the five agencies consulted (CDC, 2017b; Santé publique France, 2019; United Kingdom National Health Service, 2020) make recommendations about not leaving children alone in a car, while the other two agencies (Government of Canada, 2020; Ontario - Ministry of Health, 2015) make general recommendations, such as not leaving people or pets in a parked vehicle.

CDC make the following recommendation regarding children in cars:

- Do not leave children in a motor vehicle. The temperature inside the car can rise quickly, even with the window slightly opened. While everyone is at risk in a parked car, children are at even greater risk of suffering and dying from heat stroke. If you are travelling with children, remember to do this:
  - Do not leave babies, children or pets in a parked car, even if the windows are slightly opened.
  - To remember that there is a child in the car, always keep a stuffed animal in the child's seat. When the child is in the seat, put the stuffed animal in the seat next to the driver.
  - When you get out of the car, make sure everyone is out. Remember the children who have fallen asleep.

The interior temperature of a car can rise quickly, even with a slightly opened window (CDC, 2017b). Deaths of children left in a car during heat spells are an ever-present, but predictable, public health problem (Vanos et al., 2018). In the United States, since 1998, 860 children have died in a motor vehicle due to heat (No Heat Stroke, 2020).

5.7 Keep the home cool

The authors of a recent review by the INSPQ considered that, in summer, thermal comfort in housing is achieved when the indoor temperature is between 24 °C and 26.5 °C, and relative humidity is maintained between 30% and 50% (Levasseur et al., 2020).

5.7.1 Reduce the indoor temperature by natural means

Four of the five agencies consulted are making recommendations regarding natural ways to reduce indoor temperature (Government of Canada, 2020; Ontario – Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020). For example, the Government of Canada offers several natural measures to keep the home as cool as possible:

- Prepare meals that don't need to be cooked in the oven.
- Keep the heat and sun out by closing windows, shutters, curtains or blinds during the day.
- If it is safe to do so, open your windows at night to let cooler air into your home.

These recommendations provide some details that can be included in the MSSS recommendations. However, the scientific literature on the effectiveness of these measures in reducing heat-related health impacts is lacking. Nevertheless, these measures evidently reduce the indoor temperature of dwellings and, therefore, at least theoretically, also reduce the risks associated with heat.

5.7.2 Use an electric fan

Only two of the five agencies consulted (Government of Canada, 2020; Ontario – Ministry of Health, 2015) recommend the use of electric fans[9] to cool down. One agency even cautions against their use, as it finds that electric fans provide no benefit above temperatures of 32°C and that there are more effective ways to cool down, such as taking a shower or going to an air-conditioned place (CDC, 2017b).

The recommendation from both agencies supporting the use of electric fans is as follows:

- If your home is extremely hot, use an electric fan to help you stay cool and aim the air flow in your direction.

The scientific literature on the appropriateness of using electric fans to reduce exposure to heat is not entirely conclusive, but some studies report that, under certain conditions, electric fans are an effective solution (Bustinza and Demers-Bouffard, 2019). Electric fans could decrease cardiovascular and heat stress as if the temperature were 3°C to 4°C lower, regardless of the humidity level (Jay et al., 2015). In addition, electric fans are a simple, low-cost and energy-efficient solution and are therefore more accessible than air conditioners (Gagnon and Crandall, 2017; N. M. Ravanelli et al., 2017).

Studies in young adults indicate that the use of electric fans with indoor temperatures of 36°C and 42°C with different humidity levels delays the rise in body temperature (Ravanelli et al., 2017; Ravanelli et al., 2015; Ravanelli and Jay, 2016). However, for older adults (average age: 68 years), one study shows that the use of electric fans, also tested at different humidity levels but only at a temperature of 42°C, can actually increase body temperature (Gagnon et al., 2016).

[9] Electric fan: a device with a motor and blades, designed to create air flow to improve the user's thermal comfort.

In sum, although the use of electric fans was ineffective at excessively high indoor temperatures (≥ 42°C) in older adults, it may be beneficial at lower indoor temperatures (≤ 36°C) for individuals who hydrate adequately (Gagnon and Crandall, 2017).

Possible recommendation:

- People under age 65: If the indoor temperature in your home is below 36 °C, use an electric fan, aim the air flow in your direction and drink plenty of fluids (especially water) before you feel thirsty. If the temperature is above 36 °C, avoid using an electric fan, as this can increase body temperature even more.

5.7.3 Spend time in an air-conditioned place

Three of the five agencies consulted (CDC, 2017b; Government of Canada, 2020; Ontario – Ministry of Health, 2015) recommend cooling off in an air-conditioned place. For example, the CDC makes the following recommendation:

- Stay in air-conditioned buildings as much as you can.
- An air-conditioned place, such as a shopping mall, is a good way to reduce exposure to indoor heat during heat waves (Bustinza and Demers-Bouffard, 2019). In buildings without air conditioning in Scandinavia, indoor temperatures can reach levels 50% higher than the outdoor temperature (Lundgren Kownacki et al., 2019). Furthermore, a study in 211 U.S. cities reports that the risk of heat-related death is lower with the use of air conditioners (Nordio et al., 2015). A study in 1,916 U.S. counties also shows that the risk of hospitalization for heat stroke during a heat wave is lower in counties with higher central air conditioning prevalence (Wang et al., 2016).
- Only Health Canada makes recommendations for the ideal indoor temperature during heat events: between 22°C and 26°C (Government of Canada, 2020).

5.8 Cool down with water

5.8.1 Cool down your skin

Two of the five agencies consulted make recommendations about cooling the skin with water to lower body temperature (Government of Canada, 2020; Santé publique France, 2019). For example, Santé publique France recommends:

- Protecting yourself from the heat by regularly wetting your body to lower your body temperature (for example, by applying damp towels or cloths to your face, arms and neck or spraying water on your face).

No studies linking cooling the skin with water to reduced heat-related health risks were identified in this review of the scientific literature. However, the authors of a clinical study conclude that intermittently wetting clothing is a simple, environmentally friendly and universally accessible strategy to significantly reduce heat stress on the body associated with

heat waves for people resting or sitting in an ambient temperature of 43°C (Song et al., 2019). A recommendation based on the findings of that study could be:

- Protect yourself from the heat by wetting your clothing regularly (every 30 minutes) to lower your body temperature.

5.8.2 Take a cool shower or bath

Four of the five agencies consulted recommend taking a cool shower or bath to cool down during a heat wave (CDC, 2017b; Government of Canada, 2020; Ontario – Ministry of Health, 2015; Santé publique France, 2019). For example, the Government of Canada makes the following recommendation:

- Take cool showers or baths until you feel refreshed.

No studies that linked taking a cool shower or bath with reduced heat-related health risks were identified in this review of the scientific literature.

5.8.3 Go to a pool

Three of the five agencies recommend cooling down in a pool during heat events (Government of Canada, 2020; Ontario – Ministry of Health, 2015; United Kingdom National Health Service, 2020). For example, the Ontario Ministry of Health makes the following recommendation:

- Spend a few hours in a pool.

A Canadian study based on surveys in five cities, none in Québec, reports that 53% of parents would take their children to a pool or other body of water during a heat wave, 14% would go themselves, and only 3% of caregivers would take elderly people (Alberini et al., 2011). No studies that linked spending a few hours in a pool to reduced heat-related health risks were identified in this review of the scientific literature.

5.9 Go to a shaded or cool place

Three of the five agencies recommend cooling off in a shaded area of a park during heat events (Government of Canada, 2020; Ontario – Ministry of Health, 2015; United Kingdom National Health Service, 2020):

- Spend a few hours a day in a cool place, such as an area shaded by trees.

According to the Ontario Ministry of Health, areas shaded by trees can be up to 5°C cooler than the surrounding unshaded areas (Ontario – Ministry of Health, 2015). A study in three cities in the Netherlands showed that the ambient temperature in urban parks and green spaces was an average of 1.9°C and 0.8°C lower, respectively, compared to the city centre (Klemm et al., 2014).

5.10 Reduce physical exertion

All five agencies consulted (CDC, 2017b; Government of Canada, 2020; Ontario – Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020) recommend limiting or avoiding physical exertion. For example, the United Kingdom National Health Service makes the following recommendation:

- Avoid physical exertion in the hottest parts of the day.

5.10.1 General population

Because the human body has a very low tolerance for an increase in body temperature, during a period of extreme heat, any physical exertion, even moderate, can have a significant impact on health (Leyk et al., 2019). In addition, given that stress on the body can be hazardous to health when intense exercise lasts longer than 30 minutes (Macartney et al., 2020), an appropriate recommendation would be:

- Schedule exercise during cooler times of the day.
- Limit strenuous exercise to 30 minutes and stay adequately hydrated.

5.10.2 Workers

Among the adaptation measures that can reduce heat exposure for workers in hot environments, it is reported that work planning could be improved (Lundgren et al., 2013):

- Schedule work during cooler times of the day.

In addition, given that workers' knowledge of the risks associated with heat exposure may be limited (Bethel and Harger, 2014), an appropriate adaptation measure would be:

- Inform workers about the health effects of heat so they can recognize them and know how to prevent them (Jakson and Rosenberg, 2010).
- Employers, managers and site supervisors need to have a good understanding of heat-related health impacts in order to design and implement prevention measures suited to local conditions (Jakson and Rosenberg, 2010).

All of these measures to reduce worker heat exposure have the potential to prevent associated health impacts (McInnes et al., 2017; Xiang et al., 2014).

In Québec, other organizations, such as the INSPQ[10] and CNESST[11] propose a more exhaustive list of other preventive measures.

[10] https://www.inspq.qc.ca/nos-productions/videos/chaleur-et-sante-des-travailleurs

[11] https://www.cnesst.gouv.qc.ca/sites/default/files/publications/travailler-a-la-chaleur.pdf

5.11 Avoid alcoholic beverages

Consuming alcohol can cause dehydration and increase the risk of heat-related illnesses (N. Auger and Kosatsky, 2002). Four of the five agencies consulted (CDC, 2017b; Ontario – Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020) recommend avoiding the consumption of alcoholic beverages.

5.12 Monitor heat-related symptoms

Four of the five agencies consulted (CDC, 2017b; Government of Canada, 2020; Ontario – Ministry of Health, 2015; United Kingdom National Health Service, 2020) recommend monitoring for heat-related symptoms. For example, the Government of Canada makes the following recommendations:

- Watch for symptoms of heat-related illnesses, which include:
  - dizziness or fainting;
  - nausea or vomiting;
  - headache;
  - rapid breathing and heartbeat;
  - extreme thirst (dry mouth or sticky saliva);
  - decreased urination with unusually dark yellow urine;
  - behavioural changes in children (sleepiness or tantrums).
- If you experience any of these symptoms during hot weather, immediately move to a cool place and drink liquids, preferably water.
- While waiting for help, cool the person right away by:
  - moving them to a cool place if possible;
  - applying cold water to large areas of the skin or clothing;
  - fanning the person as much as possible.

6 POPULATION-BASED ADAPTATION MEASURES

Population-based adaptation measures are implemented by organizations and are intended to reduce the adverse impacts of heat at a population level, such as warning systems or response plans. They do not require changes to the built or natural environment.

The population-based adaptation measures evaluated in this review, in no particular order, are:

- Section 6.1: Implementing a response plan;
- Section 6.2: Setting up an early warning system;
- Section 6.3: Implementing a mapping application.

6.1 Implementing a response plan

An extreme heat response plan can reduce health impacts. In Québec, a study conducted in Montréal using a quasi-experimental method controlling for certain confounding variables indicates that the heat response plan implemented in Montréal since 2004 appears to have contributed to a significant reduction of five deaths per day during heat waves (Benmarhnia et al., 2016). Response plans can reduce health impacts, particularly if they include provisions to support those most at risk. Montréal's plan targets the most disadvantaged neighbourhoods, which has reduced the gap in heat-related mortality between the disadvantaged and the advantaged. In Rome, the increase in all-cause mortality of people age 75 and older was 50% lower in the summer of 2015, compared with the summer of 2014, in neighbourhoods where a social intervention program had been implemented that aimed to improve social support for people who are isolated or ill (Liotta et al., 2018).

Among workers, the decrease in compensation payments during extreme heat events suggests that mandatory adaptation measures (e.g., increased breaks, increased worker rotation, improved hydration monitoring, or decreased physical exertion) to be implemented above a certain temperature threshold are effective in reducing the effects of heat (Varghese et al., 2018; Xiang et al., 2014).

In Québec, the Observatoire québécois de l'adaptation aux changements climatiques at Université Laval conducted a survey in 2015 to determine the level of adaptation in the health network. The results of that survey show that two-thirds of health care facilities had an extreme heat prevention and protection plan, and three-quarters of public health departments had developed an extreme heat prevention and protection plan (Valois et al., 2017c). With regard to municipal emergency preparedness, another survey conducted the same year among 110 municipal emergency preparedness departments indicated that 50% had implemented emergency preparedness measures (e.g., mobilizing emergency personnel to respond, distributing bottled water to the public, extending the opening hours of public swimming areas, etc.) during heat waves (Valois et al., 2017b).

Evaluating the effectiveness of response plans, particularly in reducing the number of deaths during heat waves, is a complex task. Methodological challenges are a major problem for rigorous evaluation, and the choice of variables as measures for comparing health impacts remains debatable (Boeckmann and Rohn, 2014; Lebel et al., 2019). Most evaluations use a before-and-after approach that does not account for potential confounding variables (Benmarhnia et al., 2016). For instance, the effectiveness of response plans may be influenced in particular by the public's perception of the risk associated with heat and by the costs of making the necessary adaptations (Toloo et al., 2013). In a systematic review of the effectiveness of heat response plans, the majority of studies found a reduction in mortality and morbidity during heat waves in locations where preventive measures had been implemented (Boeckmann and Rohn, 2014). In five studies in the same review, public perception and behaviour were also reported to have changed following the implementation of preventive measures.

A response plan may have various components (Health Canada, 2012):

- Mobilization of partners. To prepare the community for the upcoming warm season by identifying its needs, recruiting stakeholders and developing implementation plans.
- Community response plan. To encourage individual heat protection initiatives by promoting interventions for those at risk.
- Communication and awareness plan with press releases, interviews and websites. To promote awareness of heat-related health effects, provide advice to reduce health risks through public education on prevention measures and provide information on available services and resources.
- Evaluation plan. To evaluate the timeliness, relevance and effectiveness of the measures implemented and their alignment with priorities and contribution to reducing health impacts.
- Warning system. To alert stakeholders, government officials or the public, who can then take predetermined health protection measures.
- Contingency plan. To anticipate the need to adapt certain measures, such as in the context of the COVID-19 pandemic.

6.2 Setting up an early warning system

An early warning system identifies weather conditions that could cause increased morbidity or mortality rates in a particular region. These systems give jurisdictions more time to deploy appropriate preparedness and response measures.

6.2.1 SUPREME system

In Québec, the SUPREME system was commissioned in June 2010 (Toutant et al., 2011) in response to the *Guide d'intervention chaleur accablante, volet santé publique* (Laplante and Roman, 2006). A study comparing the impacts on deaths in Québec from the 2010 and 2018 heat waves shows that excess deaths related to heat waves decreased from 291 in 2010 to 86 in

2018 (Lebel et al., 2019). This suggests that the warning system might have helped improve public health interventions to reduce health impacts.

The SUPREME warning system provides:

- Regular performance evaluations of its ability to predict heat waves accurately.
- Regular updates of the heat thresholds used to launch warnings.

6.2.2 Santé publique France's heat health watch warning system

To enhance protection for the population from the consequences of heat waves, the French Ministry of Health developed the National Heat Wave Plan in 2004, which includes a heat health watch warning system (HHWWS) (Laaidi et al., 2012). The objective of the HHWWS is to identify heat waves that are likely to have major health impacts in order to implement prevention and management measures quickly. It relies on the monitoring of weather forecasts and health indicators: the number of deaths, emergency room visits for all causes for people over age 75 and for certain heat-specific causes and the use of SOS Médecins associations [medical emergency service]. During the July 2006 heat wave, fewer deaths than expected were observed. This decrease in excess mortality can be considered a reduction in the population's vulnerability to heat waves, attributable to public awareness of the dangers of heat and the implementation of the warning system and heat wave plan measures.

6.2.3 Automated telephone alert system

A pilot project was carried out in the Montérégie region of Québec to implement an automated telephone alert system (ATAS) for the elderly or people with certain pre-existing health conditions. Participants showed an increased prevalence of intention to spend time in cool places and stay indoors compared to the control group and reported increased adoption of cooling measures (Mehiriz and Gosselin, 2017; Mehiriz et al., 2018). Women, who made up the vast majority of participants, had cut their visits to a health specialist in half compared to the control group. However, reaching people experiencing homelessness or who have no means of electronic or telephone communication remains a challenge.

These types of systems must provide (Mehiriz et al., 2018):

- An evaluation of their ability to encourage preventive behaviours.

6.3 Implementing a mapping application

In Québec, the public health geoportal developed by the INSPQ is a mapping application that presents historical spatial data to visualize various risks, vulnerable areas and protective or vulnerability factors that can influence the effects of various hazards, including heat, on human health (INSPQ, 2019).

The public health geoportal presents the following heat-related customizable indicators. These indicators come from the risk groups targeted in the literature reviews conducted by the INSPQ (Bustinza and Demers-Bouffard, 2019; Tairou et al., 2010):

- Regional deprivation index;
- Population density per square kilometre;
- Proportion or number of people in a certain group;
- Proportion or number of dwellings requiring major repairs;
- Proportion or number of immigrants received since 2011;
- Proportion or number of people who speak neither English nor French;
- Proportion or number of people age 65 and over living alone;
- Level of air conditioning;
- Density of people vulnerable as a result of chronic illness;
- Location of heat islands;
- Location of cool islands;
- Location of public pools;
- Location of recreational facilities;
- Walkability;
- Plant cover;
- Access to parks and green spaces;
- Location of MSSS facilities.

The geography and geomatics departments at Université Laval, in partnership with the INSPQ and the Ouranos consortium, completed a heat wave vulnerability mapping project (Université Laval, 2017). The maps provide information on the geographic distribution of social inequalities in relation to heat waves. These maps include information on the presence of urban heat islands, sensitivity and the ability to cope with these hazards, and vulnerability as a result of socioeconomic, demographic and health factors:

- Mapping heat wave vulnerability.[12]

In British Columbia, the interactive online Heat Impacts Prediction System is designed to support health protection during hot weather. This system, called BCHIPS[13] (British Columbia Heat Impacts Prediction System), has developed a model to predict health risk based on temperature forecasts. The system also provides an online platform to visualize the observed and forecasted temperatures as well as the health risk for the 32 identified health regions.

12 https://atlas-vulnerabilite.ulaval.ca/vague-de-chaleur/

13 https://maps.bccdc.ca/bchips/

7 STRUCTURAL ADAPTATION MEASURES

Structural adaptation measures are implemented by organizations and are intended to reduce the adverse impacts of heat at a population level. However, unlike population-based measures, structural measures require changes to the built or natural environment, such as greening or land-use planning.

The structural adaptation measures evaluated in this review, in no particular order, are:

- Section 7.1: Greening cities;
- Section 7.2: Increasing the albedo of surfaces;
- Section 7.3: Improving access to public pools;
- Section 7.4: Improving access to air-conditioned public spaces.

7.1 Greening cities

Greening, or increasing the presence of greenery (especially increasing the canopy), in built-up areas is an adaptation measure that can reduce ambient heat and the urban heat island phenomenon. A simulation suggests that a 10% increase in vegetation in the city of Toronto could cool temperatures by 0.5°C to 0.8°C during the day in summer (Wang et al., 2015). Green roofs are among the potentially beneficial greening measures, especially in urban areas (Akbari et al., 2016; Berardi, 2016; Sailor et al., 2012; Taleghani et al., 2016). In Toronto, during extreme heat events, the number of heat-related calls to ambulance services was 18 times higher in neighbourhoods with less than 5% canopy than in those with more than 70% (Graham et al., 2016). A study in 135 U.S. cities found that summer mortality was 3% higher per 7.7°C increase in the least greened neighbourhoods, controlling for the usual socioeconomic factors (Zanobetti et al., 2013). In recent years, several dozen greening projects have been implemented in Québec to combat urban heat islands in disadvantaged neighbourhoods through improved shading and rainfall management (Beaudoin, 2016; Beaudoin and Gosselin, 2016).

The following structural adaptation measure supporting greening projects could reduce heat islands and thus decrease the associated risks during heat events:

- Promote and support urban greening projects, especially for the health network.

7.2 Increasing the albedo of surfaces

In urban environments, the use of high-albedo[14] cladding materials (such as light-coloured reflective sheeting) can also increase the ability to keep cities cool in hot weather. In general, a 0.1 increase in albedo can reduce ambient temperature by approximately 1°C during extreme

[14] Albedo is the ability of materials to reflect light energy. The higher the albedo, the less heat the material retains, and the less it contributes to heat islands. Albedo, which has no dimensions, varies from 0 (no reflection) to 1 (total reflection, like mirrors).

heat events (Santamouris, 2014). According to a simulation, increasing ground albedo by 0.2 to 0.4, roof albedo by 0.3 to 0.7 and vegetation by 10% in the city of Toronto could decrease the perceived temperature by 3.3°C to 4.6°C on summer days (Wang et al., 2015). In Montréal, increasing albedo from 0.2 to 0.65 would reduce annual temperatures by up to 4°C on hot days (Touchaei and Akbari, 2015). In California, widespread implementation of reflective (high-albedo) roofing could reduce the increase in heat exposure caused by climate change by 51% to 100% in 2050 (Vahmani et al., 2019). This impact on the ambient temperature could have a direct effect on health. In three U.S. metropolitan areas (Atlanta, Philadelphia and Phoenix), a significant increase in albedo (above 0.45) could reduce projected increases in heat-related mortality by 40% to 99% by 2050 (Stone et al., 2014). Mapping urban heat islands and the level of population deprivation helps improve the targeting of interventions (Boulfroy et al., 2013; Stewart, 2011; Wang et al., 2015). In addition, high-albedo roofs have been mandatory in several Montréal boroughs for a number of years.[15]

The following structural adaptation measure supporting projects to increase albedo could reduce the associated risks during heat events:

- Promote and support projects and regulatory measures to increase the albedo of urban environments, especially for the health network.

7.3 Improving access to public pools

Three of the five government agencies consulted recommend cooling down in a public pool during heat events (Government of Canada, 2020; Ontario – Ministry of Health, 2015; United Kingdom National Health Service, 2020).

No studies linking the use of public pools to reduced heat-related health risks were identified. However, it is obvious that going to a pool can cool the body and help counter the effects of heat. In this context, the following structural adaptation measure could improve public access to public pools during heat events:

- Extend the opening hours of public pools during heat events.

7.4 Improving access to air-conditioned public spaces

All five agencies consulted (CDC, 2017b; Government of Canada, 2020; Ontario – Ministry of Health, 2015; Santé publique France, 2019; United Kingdom National Health Service, 2020) recommend cooling off in an air-conditioned public space.

Air-conditioned spaces in offices and public buildings provide a cool environment and reduce people's exposure to high temperatures (World Health Organization, 2018). A Québec study (Bélanger et al., 2008) reports that during heat waves in Québec, the most popular places for people living in apartment buildings to cool down are shopping malls and movie theatres.

[15] https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/mun/pdf/13-0616-Rosemont%20Case%20Study_e.pdf

However, widespread use of air conditioning can increase the outdoor temperature as a result of increased energy demand and the release of warm air outside (Lin et al., 2013; Lundgren and Kjellstrom, 2013). Nevertheless, moderate use of air conditioning combined with other measures (structural modifications to the roof and windows, use of reflective materials, building or neighbourhood greening, improved local rainfall management) could limit the negative effects of air conditioning while maximizing its positive effects (Giguère, 2009; Mavrogianni et al., 2012; Raji et al., 2015).

Air-conditioned public spaces should be organized and developed to respond to heat-related needs:

- Be open to the public during times of the day when indoor temperatures are typically the warmest, approximately between noon and 9 p.m.
- Be accessible in priority areas[16]:
  - low level of air conditioning use;
  - high density of older adults or people with chronic illnesses;
  - in the centre of urban heat islands;
  - with a high number of units in need of repair.
- Ensure the continuity of the electrical grid. The electrical grid may become overloaded as a result of a significant increase in energy demand, which can cause power outages that make it impossible to use air conditioners. To prevent this situation, access to a backup generator may become essential.

Other solutions are also possible to improve access to air conditioning:[17]

- Distribute air conditioners or provide financial assistance to purchase them. Those at particularly high risk, such as the elderly, who do not have access to air conditioning, either for a physical (e.g., reduced mobility) or financial (e.g., low income) reason, could be eligible for a free distribution of air-conditioning units or government financial assistance to purchase one.
- Financial support for hydro bills. People who already own an air conditioner but cannot use it because of the high cost of operating it could be eligible to receive government financial assistance to pay their hydro bills and make it more affordable to use their air conditioners.

[16] These areas can be identified on the INSPQ's public health geoportal: https://www.inspq.rtss.qc.ca/geo/portail/index.php. This site is accessible only to personnel of the health and social services network.

[17] https://www.nytimes.com/2020/05/06/climate/coronavirus-climate-change-heat-waves.html

8 ADJUSTING ADAPTATION MEASURES IN THE CONTEXT OF THE COVID-19 PANDEMIC

During heat events in the context of the COVID-19 pandemic, some of the public health recommendations to protect against the impacts of heat could be adjusted to avoid increasing the risk of infection. This chapter presents these adjustments.

The adjustments to adaptation measures presented below are based on information available at the time of writing this report. Therefore, since knowledge about COVID-19 may evolve, the adjustments recommended in this document may also need to be modified over time.

Adaptation measures that can be adjusted include, in no particular order:

- Section 8.1: Public pools;
- Section 8.2: Public parks;
- Section 8.3: Electric fans and air conditioners;
- Section 8.4: Air-conditioned public places.

8.1 Public pools

The INSPQ believes that, in a COVID-19 context, cooling off in a public pool during intense heat, particularly indoor pools, should not be a priority public health recommendation, given the risk of contracting COVID-19 and the other means of cooling off (e.g., baths and showers) that are available and accessible to everyone and do not pose risks for COVID-19 transmission (Bustinza and Gosselin, 2021). In addition, the INSPQ considers it possible that the use of public pools, particularly indoor pools and the interior spaces of facilities, poses a risk that is roughly equivalent to that of using gymnasiums (Bustinza and Gosselin, 2021), where a number of significant outbreaks have been reported. A recent INSPQ publication reports on current knowledge of the risk of COVID-19 transmission in swimming areas and provides general recommendations for users and operators (Huppé and Huot, 2021).

Possible adjustment to the individual-based adaptation measure:

- Do not use public pools if you are experiencing symptoms consistent with COVID-19, if you are waiting for a test or test result, or if you are required to self-isolate at home.
- Follow the basic health guidelines in place to limit the spread of COVID-19.

Possible adjustment to the structural adaptation measure:

- Limit the number of users so it is easier to maintain physical distancing and comply with hygiene instructions.

8.2 Public parks

COVID-19 is primarily transmitted through close contact with an infected person. The data indicate that aerosol transmission occurs when an infected person expels droplets near another person. The modes of COVID-19 transmission in the outdoor environment are presumed to be the same as those documented for the indoor environment. Nevertheless, certain parameters of the outdoor environment (e.g., temperature, wind, ultraviolet radiation) could modulate the risk of transmission by influencing the viral load of aerosols and the distance they travel in the ambient air, as well as the concentration of potentially infectious virus suspended in aerosols (Comité en santé environnementale COVID-19, 2021a; INSPQ, 2021; Comité en promotion et prévention, 2020). In addition, parks provide cool islands that help improve people's thermal comfort, which directly affects their health (Comité en promotion et prévention, 2020). They are an appropriate refuge for the population with less access to air-conditioned places.

Possible adjustments to the individual-based adaption measures:

- Do not use public parks if you are experiencing symptoms consistent with COVID-19, if you are waiting for a test or test result, or if you are required to self-isolate at home.
- Follow the basic health guidelines in place for the COVID-19 pandemic, such as physical distancing and wearing a mask or face covering.

Possible adjustments to the structural measures (Comité en promotion et prévention, 2020; Comité en santé environnementale COVID-19, 2021b):

- Improve access to public parks.
- Clean frequently touched public amenities.
- Clearly indicate hygiene, physical distancing and usage instructions.
- Provide access to public restrooms.
- Redesign facilities by, for example, making wider paths, increasing rest areas or closing off cramped areas.

8.3 Electric fans and air conditioners

Electric fans and air conditioners are devices that are widely used during extreme heat events. However, unless some precautions are taken, their use can pose a health hazard in the context of the COVID-19 pandemic. An individual with COVID-19 can generate significant viral loads in the air (Buonanno et al., 2020). The use of an electric fan or air conditioner near an infected person could theoretically expand the plume beyond two metres and contribute to virus transmission (Comité de travail sur la ventilation, 2021; Groupe de travail SAT-COVID-19, 2020). In addition, air conditioners may also contribute the virus's prolonged stability in indoor environments by generating cooler ambient temperatures and drier air, conditions conducive to its "survival" (Groupe de travail SAT-COVID-19, 2020).

For detailed information on the use of electric fans and air conditioners in health care, school and work environments, refer to the various INSPQ publications (Comité des infections nosocomiales du Québec, 2020; Potvin and Leclerc, 2021; Comité de travail sur la ventilation, 2021; Groupe de travail SAT-COVID-19, 2020).

Based on these publications, some individual measures could be adjusted to reduce the risk of contagion if the decision is made to use electric fans or air conditioners in the home of a person who is infected, has consistent symptoms or is in preventive isolation:

- The person must reside alone in their home or remain isolated in a room.
- Ensure that the place is well ventilated, either by adequately and continuously using a mechanical ventilation system, if available, or by opening windows, if possible. If windows are opened, they should be opened at least three times a day for a minimum of 15 minutes, while keeping the door to the room closed.
- Ensure that frequently touched surfaces of the electric fan or air conditioner are cleaned and disinfected at least once a day.

If the person does not live alone, add these measures:

- Turn off the oscillation mode to avoid potential radial or uncontrolled dispersion of infectious droplets or aerosols.
- Ensure that the airflow is not being directed toward the room's exit door to prevent infectious droplets or aerosols from being dispersed out of the room.
- The airflow must be directed far from the person's face.

8.4 Air-conditioned public places

Air-conditioned public places significantly reduce the population's exposure to high temperatures (Bustinza and Gosselin 2021). During the COVID-19 pandemic, these places remain essential community resources while complying with the health measures in place to reduce transmission. The CDC recommends opening air-conditioned public places during extreme heat events (CDC 2020) with some physical distancing, ventilation and cleaning measures in place (CDC 2020; Comité de travail sur la ventilation 2021; Comité en santé environnementale COVID-19 2021b).

Possible adjustment to the individual-based adaptation measure:

- Do not use public places if you are experiencing symptoms consistent with COVID-19, if you are waiting for a test or test result, or if you are required to be in preventive isolation.
- Follow the basic health guidelines in place for the COVID-19 pandemic, such as physical distancing and wearing a mask or face covering.

Possible adjustments to the structural measures:

- Post and enforce the current COVID-19 pandemic measures, i.e., those for the use of public places by people who are infected, have consistent symptoms or are in preventive isolation; those for physical distancing; and those for wearing masks and face coverings.
- Enforce indoor control measures, including ventilation and surface cleaning.

Other adjustments to structural measures are also possible to improve access to air conditioning (Bustinza 2020):

- Provide air-conditioned rooms. Rooms in hotels that are closed or less busy as a result of the COVID-19 pandemic may be provided to accommodate people during heat events. In addition, arrangements could be made to drive vulnerable people to these air-conditioned rooms using safe adapted transportation that complies with prevention measures.
- Put air-conditioned adapted buses into operation. These buses must have sufficient natural or mechanical ventilation. It is also recommended that users follow prevention and control measures such as wearing masks and practising hand hygiene. As an alternative, air-conditioned public transit buses could also be used.
- Improve access to air conditioners. Whether they are purchased through financial assistance or distributed for free, improved access would be beneficial for people at risk who are experiencing symptoms consistent with COVID-19, who are waiting for testing or test results or who are in preventive isolation, and who, as a result, would not be able to use air-conditioned places because of the public health measures in place.

9 CONCLUSIONS AND RECOMMENDATIONS

This section includes an overview of the key conclusions of this review concerning at-risk populations and adaptation measures that can help reduce the population's exposure or sensitivity to heat.

These conclusions and recommendations are presented in sections:

- Section 9.1: At-risk populations
- Section 9.2: Individual-based adaptation measures
- Section 9.3: Population-based adaptation measures
- Section 9.4: Structural adaptation measures
- Section 9.5: Adaptation measures in the context of the COVID-19 pandemic
- Section 9.6: Relevance of the risk groups identified by the MSSS
- Section 9.7: Relevance of the adaptation measures recommended by the MSSS

9.1 At-risk populations

A number of populations are considered to be at risk from heat. The health impacts of intense heat can vary, depending on individual clinical and physiological characteristics. Table 1 outlines these at-risk populations, the current MSSS terms for these groups and the conclusions from this review.

Table 1 People at risk from heat: MSSS wording and conclusions

People at risk	MSSS[a]	Current MSSS wording and conclusions
• Older adults	Yes	Current MSSS wording: *"Older adults."* **Conclusion**: Keep this group among the risk groups.
• Infants and young children	Yes	Current MSSS wording: *"Babies and children under 5 years of age."* **Conclusion**: Keep this group among the risk groups.
• Pregnant women and their foetus	No	**Conclusion**: Include this group among the risk groups.
• Men	No	**Conclusion**: Do not include this group among the risk groups.
• People with chronic diseases	Yes	Current MSSS wording: *"People suffering from chronic illnesses or severe mental health problems."* **Conclusion**: Keep this group among the risk groups.

Table 1 People at risk from heat: MSSS wording and conclusions (cont'd)

People at risk	MSSS[a]	Current MSSS wording and conclusions
• People who take certain medications	Yes	Current MSSS wording: *"People who take certain medications that can aggravate the effects of heat."* **Conclusion**: Keep this group among the risk groups and consider adding the following individual-based adaptation measure: • Consult your doctor, pharmacist or clinical nurse to adjust, if necessary, the doses of certain medications taken on a regular basis.
• People with reduced autonomy or who live alone	Yes	Current MSSS wording: *"People with reduced autonomy or who live alone."* **Conclusion**: Keep this group among the risk groups and consider adding the following details: • People with reduced mobility. • People with limited contact with family or friends (e.g., single people).
• People who do not have access to cool or air-conditioned places	Yes	Current MSSS wording: *"People who do not have access to cool or air-conditioned places."* **Conclusion**: Keep this group among the risk groups.
• People with drug or alcohol use problems	Yes	Current MSSS wording: *"People with drug or alcohol use problems."* **Conclusion**: Keep this group among the risk groups.
• People who work in high-temperature environments	Yes	Current MSSS wording: *"People with physically demanding jobs or who work in the sun or outdoors, such as construction workers."* *"People who work in places where processes emit heat, such as foundries or bakeries."* **Conclusion**: Keep these groups among the risk groups and consider adding the following detail to the first group: • Agricultural workers.
• People who are in poor physical condition or who are overweight	Yes	Current MSSS wording: *"People who are in poor physical condition or who are overweight."* **Conclusion**: Keep this group among the risk groups.
• Visible minorities	No	**Conclusion**: Do not include this group among the risk groups.
• People who do intense physical exercise	Yes	Current MSSS wording: *"People who do intense physical exercise outside in hot weather or indoors in places that do not have air conditioning or are poorly ventilated."* **Conclusion**: Keep this group among the risk groups.

[a] Government of Québec. "The health effects of heat": Available from https://www.quebec.ca/en/health/advice-and-prevention/health-and-environment/the-effects-of-oppressive-and-extreme-heat. Accessed May 26, 2021.

9.2 Individual-based adaptation measures

The various agencies examined outlined a number of individual-based heat adaptation measures (taken by individuals). Many of these measures are situational to reduce heat exposure, but others are general ones for reducing heat sensitivity. Table 2 presents these individual-based adaptation measures, the current MSSS recommendations and details, and the conclusions from this review.

Table 2 Individual-based heat adaptation measures: MSSS wording and conclusions

Individual-based adaptation measures	MSSS[a]	Current MSSS wording and conclusions
• Arrange for visits from your loved ones	Yes	Current MSSS wording: *"Stay in touch with your loved ones and do not hesitate to ask family and friends for help."* **Conclusion**: Keep the recommendation. Since visitors can better identify signs of heat illnesses in person than over the telephone, consider adding the following details: For people at risk: • Arrange for regular visits with loved ones (family, neighbours or friends) during extreme heat events. For loves ones of people at risk: • Regularly visit your loved ones, especially people who are elderly, have reduced mobility or live alone, during extreme heat events.
• Get in shape	No	**Conclusion**: Consider this recommendation: Prepare for the heat: get in shape to reduce the risks.
• Monitor the weather	No	**Conclusion**: Consider this recommendation: Stay tuned to local weather forecasts and alerts so that you will know when to take extra precautions.
• Hydrate	Yes	Current MSSS wording: For adults: *"Drink a lot of water. Don't wait until you feel thirsty. Follow your doctor's instructions for the amount of liquid to drink, where applicable."* For babies and children: *"Make sure your children drink enough fluids:* • Have them drink water regularly and, if possible, give them a water bottle. • For breastfed babies, breastfeed on demand. It is completely normal for the baby to nurse more often. • For formula-fed babies, offer formula more often. • For babies over six months of age, offer small amounts of water after or between feeds. **Conclusion**: Keep the recommendations.

Table 2 Individual-based heat adaptation measures: MSSS wording and conclusions (cont'd)

Individual-based adaptation measures	MSSS[a]	Current MSSS wording and conclusions
• Wear temperature-appropriate clothing	Yes	Current MSSS wording: "wear lightweight clothing." **Conclusion**: Keep the recommendation and consider adding the following details: • Wear loose-fitting and light-coloured clothing. • Wear a wide-brimmed breathable hat.
• Protect children	Yes	Current MSSS wording: "Protect children from the heat: • dress them in light clothing; • cover their head with a wide-brimmed hat; • never leave them alone in a poorly ventilated room; • never leave them alone in a car." **Conclusion**: Keep the recommendation and consider adding the following details: • Never leave children alone in a parked car, even if the windows are cracked open. • Make sure everyone gets out before leaving the parked car. • Use a stuffed animal as a reminder that there is a child in the car: always keep a stuffed animal in the child's seat and, when the child is in the seat, place the stuffed animal in the seat next to the driver.
• Reduce the indoor temperature by natural means	Yes	Current MSSS wording: *"Close the curtains or blinds when the sun is out."* **Conclusion**: Keep the recommendation and consider adding the following details: • During the day, close windows, curtains, blinds or shutters in rooms that face the sun to prevent sunlight and heat from entering. • At night, if the outside temperature is lower than the inside temperature, open the windows to ventilate the house with the cooler air from outside. • Preferably, prepare meals that do not need to be cooked to avoid the heat generated by heating elements. • Keep interior lights in your home off or dimmed. Minimize your use of heat-producing appliances (e.g., televisions, dryer). • Stay on lower floors, if applicable. If you live in a house, plant large trees on the side where the sun hits the house during the hottest part of the day.

Table 2 Individual-based heat adaptation measures: MSSS wording and conclusions (cont'd)

Individual-based adaptation measures	MSSS[a]	Current MSSS wording and conclusions
• Use an electric fan	No	This review does not determine the usefulness of electric fans during heat events. However, given that fans are a simple, affordable, energy-efficient, and highly accessible solution, it should be assessed whether or not to add a recommendation that fans be used in the homes of people under 65. Two of the five agencies consulted recommend the use of electric fans. **Conclusion**: Consider adding this recommendation: • People under age 65: If the indoor temperature in your home is below 36 °C, use an electric fan, aim the air flow in your direction and drink plenty of fluids (especially water) before you feel thirsty. If the temperature is above 36 °C, avoid using an electric fan, as this can increase body temperature even more.
• Spend time in an air-conditioned place	Yes	Current MSSS wording: *"spend a few hours a day in an air-conditioned place."* **Conclusion**: Keep the recommendation.
• Cool down your skin	Yes	Current MSSS wording: *"cool your skin with a wet towel several times a day."* **Conclusion**: Keep the recommendation and consider adding the following details: • Wet your skin regularly by placing, for example, cool wet cloths on your face, arms and neck and by spraying cold water on your face.
• Take a cool shower or bath	Yes	Current MSSS wording: "take a cool shower or bath as often as necessary." **Conclusion**: Keep the recommendation.
• Go to a pool	No[b]	**Conclusion**: Consider this recommendation: Spend a few hours in a pool.
• Go to a park	No[b]	**Conclusion**: Consider this recommendation: Spend a few hours in a cool place, such as an area shaded by trees.
• Reduce physical exertion	Yes	Current MSSS wording: "reduce physical exertion." **Conclusion**: Keep the recommendation and consider adding the following details: • Stay adequately hydrated. • Schedule exercise for the cooler parts of the day (e.g., before 11 a.m. or after 4 p.m.). • Workers: Inform workers about the health effects of heat so that they can recognize them and know how to prevent them. Follow the recommendations of the Commission des normes de l'équité de la santé et de la sécurité du travail (CNESST)[c]. Employers: Employers, supervisors and forepersons need to have a good understanding of heat-related health impacts in order to design prevention measures suited to local conditions.

Table 2 Individual-based heat adaptation measures: MSSS wording and conclusions (cont'd)

Individual-based adaptation measures	MSSS[a]	Current MSSS wording and conclusions
• Avoid alcoholic beverages	Yes	Current MSSS wording: "Avoid alcoholic beverages, because alcohol can make dehydration worse." **Conclusion**: Keep the recommendation.
• Monitor heat-related symptoms	Yes[d]	Current MSSS wording: "It is important to monitor any deterioration in the health of an adult who has the following symptoms: • Headaches • Muscular cramps • Swollen hands, feet and ankles • Appearance of small red bumps on the skin, called a 'heat rash' • Unusual fatigue or exhaustion • Generalized malaise • Signs of dehydration: - Intense thirst - Less frequent need to urinate - Dark urine - Dry skin - Rapid pulse and breathing" **Conclusion**: Keep the recommendation and consider adding the following details: Symptoms include: • Nausea or vomiting; • Drowsiness or temper tantrums in children. • If you experience any of these symptoms, immediately go to a cool place and drink water. • If someone else is experiencing these symptoms, cool them immediately as you wait for help: - move them to a cool place, if possible; - apply cold water to large areas of the skin or clothing; - fan the person as much as possible.

[a] Government of Québec. "Preventing the effects of heat." Available from https://www.quebec.ca/en/health/advice-and-prevention/health-and-environment/preventing-the-effects-of-oppressive-and-extreme-heat. Accessed May 26, 2021.

[b] The recommendations were updated during the COVID-19 pandemic and adapted accordingly. This may explain the absence of the recommendation to avoid conflict with existing physical distancing standards.

[c] https://www.cnesst.gouv.qc.ca/fr/organisation/documentation/formulaires-publications/travailler-chaleur

[d] Government of Québec. "The health effects of heat": Available from https://www.quebec.ca/en/health/advice-and-prevention/health-and-environment/the-effects-of-oppressive-and-extreme-heat. Accessed May 26, 2021.

9.3 Population-based adaptation measures

The various agencies examined outlined a number of population-based heat adaptation measures (organization-initiated). Table 3 presents these population-based heat adaptation measures and the recommendations from this review.

Table 3 Population-based heat adaptation measures: conclusions

Population-based adaptation measures	MSSS	Conclusions
• Implement a response plan	Yes	Keep the measure. Important aspects to consider or strengthen: • Engaging partners to prepare the community for the upcoming warm season by identifying its needs, recruiting stakeholders and developing implementation plans. • A community response plan to encourage individual heat protection initiatives by promoting interventions for those at risk. • A communication and outreach plan, which uses press releases, interviews and websites, to promote awareness of heat-related health effects, provide advice to reduce health risks through public education on prevention measures, and provide information on available services and resources. • An evaluation plan to assess the timeliness, relevance and effectiveness of the measures implemented and their alignment with priorities and contribution to reducing health impacts. • A warning system to alert stakeholders, government officials and the public, who can then take predetermined health protection measures. • A contingency plan to anticipate certain regulations being adapted in the context of the COVID-19 pandemic.
• Setting up an early warning system: SUPREME	Yes	Keep the measure. Important aspects to consider or strengthen: • Regular performance evaluations of its ability to predict heat waves. • Regular updates of the heat thresholds used to launch warnings.
• Set up an automated telephone alert system: ATAS	No	The implementation of such a system should be considered for certain high-risk populations. Important aspect: • An assessment of the system's ability to bring about preventive behaviours.
• Implement a mapping application: public health geoportal	Yes	Keep the measure. Consideration should be given to adding this information to the application: • An indicator of heat wave vulnerability.

9.4 Structural adaptation measures

The various agencies examined outlined only four structural heat adaptation measures (requiring changes to the environment). Table 4 presents these structural heat adaptation measures and the recommendations from this review.

Table 4 Structural heat adaptation measures: conclusions

Structural adaptation measures	MSSS	Conclusions
• Green cities	Yes[a]	Consider this measure: • Promote and support urban greening projects and regulatory measures that contribute to canopy expansion, especially for the health network.
• Increase the albedo of surfaces	Yes[b]	Consider this measure: • Promote and support projects and regulatory measures to increase the albedo of urban environments, especially for the health network.
• Improve access to public pools	No	Consider this measure: • Extend the hours of operation of public pools during heat events.
• Improve access to air-conditioned public places	No	Consider these measures: • Make these places available during times of the day when indoor temperatures are typically the warmest, from roughly noon to 9 p.m. • Air-conditioned places should be accessible in priority areas, that is, areas with the following: - low level of air conditioning use; - high density of older adults or people with chronic illnesses; - in the centre of urban heat islands; - a high number of dwellings requiring major repairs. • Ensure the continuity of the electrical grid. The electrical grid may become overloaded as a result of a significant increase in energy demand, which can cause power outages that make it impossible to use air conditioners. To prevent this situation, access to a backup generator or a high-capacity battery may become essential. • Distribute air conditioners or provide financial assistance to purchase them. Those at particularly high risk, such as the elderly, who do not have access to air conditioning, either for a physical (e.g., reduced mobility) or financial (e.g., low income) reason, could be eligible for a free distribution of air-conditioning units or government financial assistance to purchase one. • Financial support for hydro bills. People who already own an air conditioner but cannot use it because of the high cost of operating it could be eligible to receive government financial assistance to pay their hydro bills and make it more affordable to use their air conditioners.

[a] 100 degrés. "Lutte aux îlots de chaleur : 8 M$ pour des projets de verdissement en milieu défavorisé." Available from https://centdegres.ca/magazine/amenagement/lutte-aux-îlots-chaleur-8-m-projets-verdissement/. Accessed July 13, 2020.

[b] MSSS: Boisselle et al. (2010) "Gestion écoresponsable des terrains." Available from https://publications.msss.gouv.qc.ca/msss/fichiers/2010/10-733-03.pdf. Accessed May 25, 2021.

9.5 Heat adaptation measures in the context of the COVID-19 pandemic

This review also identified heat adaptation measures in the context of the COVID-19 pandemic that could be adjusted or added to avoid increasing the risk of infection. Table 5 shows the adaptation measures that can be adjusted, the current MSSS recommendations and the suggested recommendations.

Table 5 Heat adaptation measures in the context of the COVID-19 pandemic: conclusions

Adaptation measures in the context of the COVID-19 pandemic	MSSS[a]	Current MSSS wording and conclusions
• Regarding public pools	No	**Conclusion:** Consider these measures: Individual-based measure • Do not use public pools if you are experiencing symptoms consistent with COVID-19, if you are waiting for a test or test result, or if you are required to self-isolate at home. • Users must follow the basic health guidelines in place to limit the spread of COVID-19. • Structural measure • Limit the number of users so it is easier to maintain physical distancing and comply with hygiene instructions.
• Regarding public parks	No	**Conclusion:** Consider these measures: Individual-based measure • Do not use public parks if you are experiencing symptoms consistent with COVID-19, if you are waiting for a test or test result, or if you are required to self-isolate at home. • Follow the basic health guidelines in place for the COVID-19 pandemic, such as physical distancing and wearing a mask or face covering. Structural measure • Improve access to public parks. • Clean frequently touched public amenities. • Clearly indicate hygiene, physical distancing and usage instructions. • Provide access to public restrooms. • Redesign facilities by, for example, making wider paths, increasing rest areas or closing off cramped areas.

Table 5 Heat adaptation measures in the context of the COVID-19 pandemic: conclusions (cont'd)

Adaptation measures in the context of the COVID-19 pandemic	MSSS[a]	Current MSSS wording and conclusions
• Regarding electric fans and air conditioners	No	**Conclusion:** Consider these measures: Individual-based measures in the home of a person who is infected, who has consistent symptoms or who is in preventive isolation. • The person must reside alone in their home or remain isolated in a room. • Ensure that the place is well ventilated, either by adequately and continuously using a mechanical ventilation system, if available, or by opening windows, if possible. If windows are opened, they should be opened at least three times a day for a minimum of 15 minutes, while keeping the door to the room closed. • Ensure that frequently touched surfaces of the electric fan or air conditioner are cleaned and disinfected at least once a day. If the person does not live alone, add these measures: • Turn off the oscillation mode to avoid potential radial or uncontrolled dispersion of infectious droplets or aerosols. • Ensure that the airflow is not being directed toward the room's exit door to prevent infectious droplets or aerosols from being dispersed out of the room. • The airflow should be directed away from the person's face.
• Regarding air-conditioned public spaces	Yes	Current MSSS wording: "*If you are in an air-conditioned public space, respect the two-metre physical distance and follow the health guidelines*." **Conclusion:** consider adding these details: Individual-based measure • Do not use public spaces if you have symptoms consistent with COVID-19, if you are waiting for a test or test result or if you are required to be in preventive isolation. • Follow the basic health guidelines in place for the COVID-19 pandemic, such as physical distancing and wearing a mask or face covering. Structural measures: • Post and enforce the current pandemic measures for COVID-19, i.e., those on the use of public spaces by people who are infected, have consistent symptoms or are in preventive isolation, those on physical distancing and those on wearing of masks and face coverings. • Enforce indoor control measures, including ventilation and surface cleaning.

Table 5 Heat adaptation measures in the context of the COVID-19 pandemic: conclusions (cont'd)

Adaptation measures in the context of the COVID-19 pandemic	MSSS[a]	The MSSS's current wording and conclusions
• Regarding air-conditioned public spaces (Cont'd)		Structural measures to improve access to air conditioning • Provide air-conditioned rooms. Rooms in hotels that are closed or less busy as a result of the COVID-19 pandemic may be provided to accommodate people during heat waves. In addition, arrangements could be made to drive vulnerable people to these air-conditioned rooms using safe adapted transportation that comply with prevention measures. • Use air-conditioned buses. These buses must have sufficient natural or mechanical ventilation. It is also recommended that users follow prevention and control measures such as wearing masks and practising hand hygiene. As an alternative, air-conditioned public transit buses could also be used. Improve access to air conditioners. Whether they are purchased through financial assistance or distributed for free, improved access would be beneficial for at-risk individuals who are experiencing symptoms consistent with COVID-19, who are waiting for testing or test results or who are in preventive isolation, and who, as a result, would not be able to use air-conditioned spaces because of the public health measures in place.

[a] Government of Québec — Prévenir les effets de la chaleur : https://www.quebec.ca/sante/conseils-et-prevention/sante-et-environnement/prevenir-les-effets-de-la-chaleur-accablante-et-extreme/, consulted on May 26, 2021.

9.6 Relevance of the risk groups targeted by the MSSS

According to this literature review, all of the risk groups during a period of heat already identified by the MSSS are still highly relevant. These risk groups are substantially similar to those identified by the other government agencies reviewed and are also consistent with the most current scientific knowledge regarding the factors of people's vulnerability during significant heat events. In addition, this review recommended adding a new risk group: pregnant women and their foetus.

9.7 Suitability of the adaption measures recommended by the MSSS

The MSSS-recommended adaptation measures to reduce the public's exposure or sensitivity to heat all remain highly relevant based on the results of this literature review. Indeed, these measures are very similar to those issued by reviewed government agencies and respond well to the most current scientific knowledge about the risks associated with heat waves, and the factors that impact population exposure. This review also identified potential improvements to some of the MSSS recommendations to further reduce health risks.

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