HEAT MORTALITY AND MORBIDITY SURVEILLANCE IN EUROPEAN COUNTRIES

TECHNICAL REPORT

Contents

1. Introduction

This study provides an overview of the approaches to surveillance of mortality (i.e. deaths) and morbidity (i.e. illnesses) associated with high temperatures in European countries. This information was collected to understand the preparedness to heat in Europe and to encourage knowledge transfer and experience sharing among the countries.

National Public Health Institutes (NPHIs) and equivalent institutions responsible for public health in members and cooperating countries of the European Environment Agency were surveyed on their approaches to monitoring heat-related health impacts. The study covers various types of surveillance activities (forecasting of mortality in anticipation of a heatwave; near-real time monitoring during or directly after a heatwave; evaluation of health impacts after a heatwave) as well as presence of heat-health action plans.

An online questionnaire survey (see Appendix 1) was open for submissions between 16 May 2024 and 19 July 2024. The survey was administrated and analysed by Ramboll under a framework contract for the EEA. The International Association of National Public Health Institutes (IANPHI) committee on climate change and health lead on the preparation and dissemination of the questionnaire and contributed to the analysis of the results.

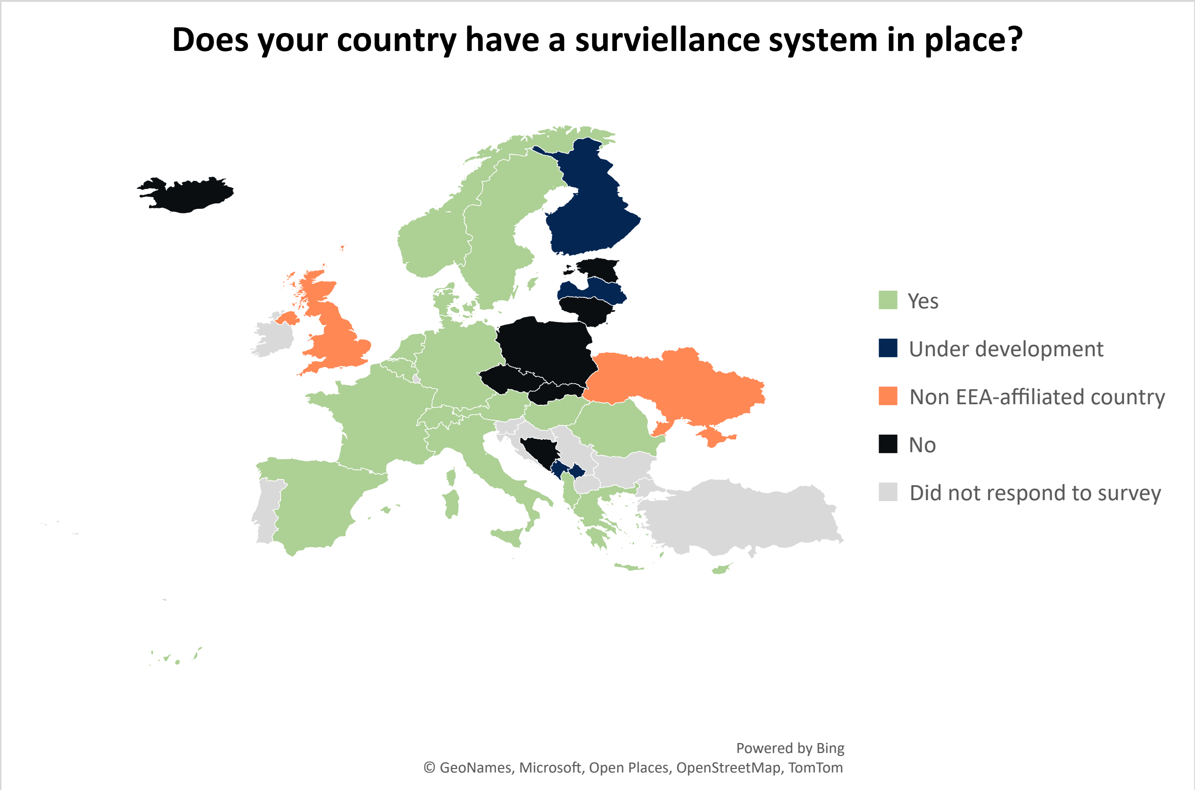
Section 2 provides an overview of surveillance activities of heat-related health impacts across EEA countries. Section 3 offers more details on how countries forecast, monitor, or evaluate heatwaves- and heat-related health impacts, what methods are employed, and how findings are reported and disseminated. Finally, Section 4 provides an overview of heat-health action plans across the EEA member and cooperating countries.

2. Monitoring heat and its health effects: an overview

2.1 Monitoring heat-related health impacts

In total, 28[1] of the 38 EEA member and cooperating countries responded to the survey (74% response rate). 17 countries[2] stated they monitor heat-related health impacts. Four countries responded that monitoring approaches are currently under development, and another seven responded 'no'. The countries that do not monitor heat-related health impacts tend to concentrate in Northeastern Europe (Map 1).

Map 1. Monitoring heat-related health impacts across Europe



The seven respondents who selected 'no' provided the following reasons for this through a closed question with three response options:

- '*heat has not been identified as a priority in the NPHI's working plan*' (Czechia, Iceland, Slovakia)
- '*there is currently no data available to the NPHI to carry out such monitoring*' (Bosnia and Herzegovina, Lithuania, Poland)

[1] Albania, Austria, Belgium, Bosnia and Herzegovina, Cyprus, Czeck Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Italy, Kosovo, Latvia, Lithuania, Malta, Montenegro, Netherlands, Norway, Poland, Romania, Slovakia, Spain, Sweden, Switzerland

- '*heat is not in the scope of the NPHIs focus*' (Estonia).

The four respondents who selected 'under development' were asked to describe the development status. The results from these countries showed that in general, some kind of collection and/or analysis of heat-related health impacts is already underway. Finland was the only country that provided a specific date for introducing a system for monitoring heat-related health effects, planned for 2026.

2.2 Defining 'heat' and 'heatwaves'

Across EEA-affiliated countries, the terms "heat" and "heatwave" are defined differently. For heat, definitions include absolute temperature thresholds (absolute Tmax), absolute daily mean temperature values over a temperature threshold or over a specific level compared to historic values, or heat index-based temperature measurements (also known as apparent temperature, considering also humidity and in certain instances other factors such as wind chill factor).

For heatwaves, the most commonly applied definitions include a threshold of consecutive days of maximum temperatures, average maximum temperature over a number of days or above a certain threshold. Sometimes definitions include a secondary criteria such as number of days with even higher temperatures or minimum temperature thresholds. Here, Italy stands out as the only country to define heatwaves based on the expected mortality impacts instead of temperature measurements. The approach used by the individual countries is summarised in Table 1.

Table 1. Definitions of heat and heatwaves used in monitoring of health impacts

Country	Heat	Heatwave
Austria	Based on thermal comfort temperature, no precise value provided.	3 consecutive days with Tmax above or equal to 30°C[3]
Belgium	Absolute daily Tmax, above or equal to 28°C	5 consecutive days with Tmax above or equal to 25°C and 3 days with Tmax above or equal to 30°C
Denmark	Max temperature > 28 degrees Celcius	A period of minimum three consecutive days with a max temperature > 28 degree Celcius per day
Cyprus	Apparent Tmax, no precise value provided	3 consecutive days with Tmax above or equal to 40°C (on plain areas).
France	Daily mean absolute temperature above the 50th percentile of the 2014-2022 mean temperature distribution	3-day moving average with both Tmax and Tmin above the 99.5th percentile of the 1980-2010 temperature distribution
Germany	Daily mean absolute temperature, above 20°C (24-hour average)	7 days with mean temperature above 20°C is defined as hot week, one or more hot weeks is defined as heatwave.
Greece	Hot temperatures, no precise value provided	Measured relative to the usual climate in the area and distribution of temperatures for the season, no details provided.
Hungary	Absolute Tmax, above or equal to 30°C	3 consecutive days with daily mean temperature above or equal to 25°C

[3] Austria responded that they mostly use the definition developed by Jan Kysley, but did not provide any further information. The definition presented here was derived from the following article: https://www.meduniwien.ac.at/web/en/about-us/news/detailsite/heat-wave-in-future-it-will-be-even-hotter-and-more-detrimental-to-health/

Country	Heat	Heatwave
Italy	Apparent Tmax, no precise value provided	3 consecutive days with heat warnings, issued when excess in mortality due to heat is predicted at ≥20%[4]
Malta	Higher than average temperature, no precise value provided	3 consecutive days with Tmax exceeding the average Tmax of the month by 5°C or more
The Netherlands	Absolute Tmax, above or equal to 27°C	5 consecutive days with Tmax above or equal to 25°C and minimum 3 days with Tmax above or equal to 30°C
Norway	Not defined	3 consecutive days with Tmax above or equal to 28°C
Romania	Absolute Tmax above or equal to 30°C and Tmin above or equal to 20°C	Tmax above or equal to 30°C and Tmin above or equal to 20°C
Spain	Absolute Tmax, precise value differs between different isoclimatic zones[5]	3 consecutive days above Tmax, precise value differs between different isoclimatic zones
Sweden	Absolute Tmax, above or equal to 26°C	3 consecutive days with Tmax above or equal to 26°C

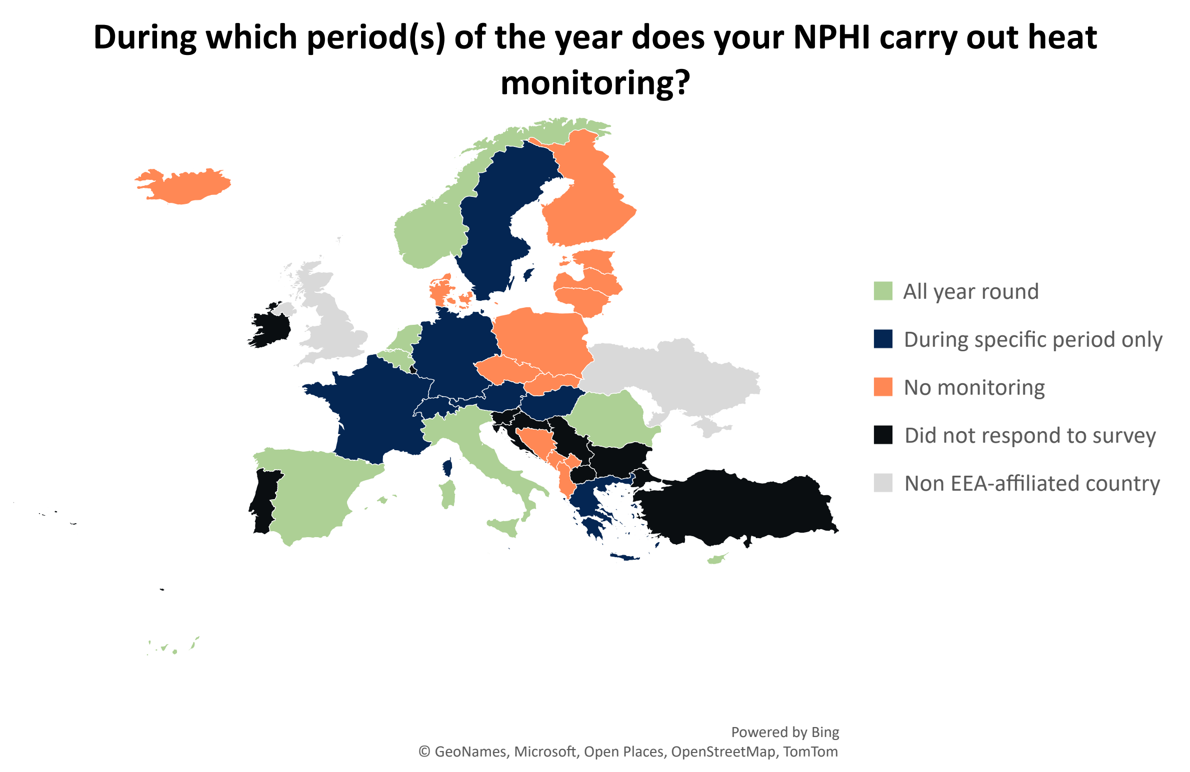
2.3 Monitoring periods

Seven countries conduct monitoring year round, and eight do so only during specific periods. There is no clear geographical patterns across countries with regards to the timing of monitoring activities (Map 2).

[4] The Italian Heat Warning System defines city-specific threshold temperatures for warning levels (0-3) through analysis of temperature-mortality association. Heatwaves (level 3 warnings) are defined as 3 or more consecutive days of level 2 warnings. Threshold varies by month to account for acclimatization.

[5] The threshold temperature value has been defined for 182 isoclimatic zones (also called Meteoalert zones; territorial areas which are uniform in terms of climate pattern of various meteorological parameters) based on assessments of for which temperature mortality increases sharply in each of the different regions or, if not possible, by using the 95th percentile of the most recent time series of maximum daily temperatures. Read more here: https://www.sanidad.gob.es/areas/sanidadAmbiental/riesgosAmbientales/temperaturasExtremas/planAltasTemperaturas/2024/temperaturasExcesivas.htm

Map 2. Overview of heat monitoring periods



For the countries that only monitor during specific periods, this ranges from the months July and August (in Malta) to the "entire summer half", as per response from Austria (Table 2).

Table 2. Monitoring periods in countries that monitor during specific periods

Country	Austria	France	Germany	Greece	Hungary	Malta	Sweden
Monitoring period	Entire summer half	1 June – 15 Sep	June – Sep	Summer	June – Aug	July – Aug	May – Sep

Note: Data presented here is based on free text field in the survey. Therefore, time intervals given by survey respondents differ.

3. Analysis of countries' surveillance of heat-related health impact

Under the umbrella term of surveillance of heat impacts of health, three complementary approaches can be distinguished: 1) forecasting the impacts before they occur to mobilise resources and prepare for action (indicated by 8 responding countries); 2) monitoring the impacts during the heatwaves to support rapid decision making (12 countries); and 3) evaluation of the health impact of heatwaves after they have happened to support longer-term decision making (11 countries). Table 3**Error! Reference source not found.** outlines which countries carry out surveillance during each phase; several countries do so during two or more of these stages.

Table 3. Countries with surveillance activities before, during, or after a heatwave

Countries	Forecasting impacts before heatwaves based on weather reports	Monitoring impacts during heatwaves	Evaluating impacts after heatwaves
Albania	x	x	
Austria			x
Belgium		x	x
Cyprus	x	x	
Denmark		x	x
France		x	x
Germany	x	x	x
Greece		x	
Hungary	x	x	x
Italy	x	x	x
Malta	x	x	x
Netherlands	x	x	
Norway			x
Romania			x
Spain	x	x	
Sweden		x	x
Switzerland			x

Sections 3.1 – 3.3 summarise the country survey responses in relation to the three phases.

3.1 Forecasting health impacts before heatwaves

Eight countries (Albania, Cyprus, Germany, Hungary, Italy, Malta, the Netherlands and Spain) indicated that they use weather forecasts to predict health impacts from high temperatures. However, among these countries only a couple provided further specifications about the process and model used to forecast health effects:

- In **Italy**, Heat Health Watch Warning Systems (HHWWS) has been in place since 2004. It covers all regional capitals and cities with more than 200,000 inhabitants. The system has a particular

focus on people aged 65 and over. The HHWWS models are based on empirical data and use weather forecasts to predicts at-risk conditions for the following 72 hours, according to a four-level grade:
  - Level 0 - no risk,
  - Level 1 - attention (low risk, <20% excess in mortality),
  - Level 2 - alarm (high risk, ≥20% excess in mortality,
  - Level 3 – emergency (third consecutive day with level 2 heat).
- In **Spain**, heat-related health risks for the following 72 hours are predicted based on data from the national meteorological agency (Agencia Estatal de Meteorología, AEMET), and presented via a risk level map for 182 isoclimatic zones. Similar to Italy, the risk levels follow a five-grade scale (level 0-4), defined by previous studies on the relationship between certain temperatures and significant increases in mortality for each zone.

3.2 Monitoring of impacts during heatwaves

This section examines monitoring approaches during or shortly after heatwaves as a method for supporting rapid decision-making. This includes estimating the health impact through near-real-time monitoring (data available within one week after a heatwave) and/or rapid reporting (data available between one week and one month after a heatwave).

13 of the responding countries[6] stated that they monitor health impacts during heatwaves. Five of these – Belgium, France, Hungary, Italy, and the Netherlands - have been conducting monitoring during heatwaves for over 10 years.

While all 13 countries monitor mortality, the monitoring of morbidity is only conducted by 7 countries, with emergency room visits being the most common method (Table 4).

Table 4. Type of data being monitored during heatwaves

Country	Mortality	Morbidity			
		Emergency room visits	Ambulance calls	Hospital admissions	GP consultations
Albania	X	-	X	-	X
Belgium	X	-	-	-	-
Cyprus	X	-	-	-	-
Denmark	X	-	-	-	-
France	X	X	-	-	X
Germany	X	-	-	-	-
Greece[7]	X	X	X	X	-
Hungary	X	-	X	-	-
Italy	X	X	-	-	X
Malta	X	X	X	X	X
The Netherlands	X	-	-	-	-
Spain	X	X	X	X	X
Sweden	X	-	-	-	-

[6] Belgium, Cyprus, France, Germany, Greece, Hungary, Italy, Malta, the Netherlands, Spain, Sweden

[7] Emergency room visits, Ambulance calls and Hospital admissions are monitored by another authority, separate from the NHPI. Hence it is not covered in table 7.

3.2.1 Monitoring heat-related mortality during heatwaves

Among the 13 countries that monitor all-cause mortality during heatwaves, 6 do so on the daily basis; 4 – weekly and 1 – monthly. In two countries monitoring is done at the country level, the majority do so at subnational level (5 – regional and 4 – local). All countries break down the mortality data by age groups (albeit in different intervals), and 8 also provide breakdown by gender (Table 5).

Table 5. Mortality data used to monitor impacts during heatwaves

Country	Smallest temporal resolution	Smallest geographical resolution	Data broken down by sex	Data broken down by age	Age groups (years)
Albania	Weekly	Municipalities /local	X	X	No data provided
Belgium	Daily	Regional	X	X	0-4, 5-14, 15-64, 0-64, 65-84, 85+
Denmark	Daily	Country	-	X	0-14, 15-44, 45-64, 65-74, 75,84, 85+, Total
Cyprus	Monthly	Regional	X	X	5-year intervals, 95+
France	Daily	Departmental[8]	-	X	1-year intervals, 74+
Germany	Weekly	Regional	X	X	0-64, 65-74, 75-84, 85+
Greece	Weekly	Country	-	X	0-14, 15-44, 45-64, 65-74, 75-84, 85+
Hungary	Daily	Municipalities /local	X	X	0-64, 65+
Italy	Daily	Municipalities /local	X	X	0-64, 65-74,74-84, 85+
Malta	Daily	Country	-	X	Not specified
The Netherlands	Weekly	Regional	X	X	0-64, 65-79, 80+
Spain	Daily	Isoclimatic zones[9]	X	X	0-14, 15-44, 45-64, 65-74, 75-84, 85+
Sweden	Weekly	Regional	X	X	1-year intervals

[8] In France, there are 96 departments, which are administrative units between the regions and communes (municipalities).

[9] Spain has 182 such zones.

Most countries analyse heat impacts by either estimating excess mortality or by more advanced epidemiological modelling of heat attributable mortality. In the case of Cyprus, only descriptive analysis is made (Table 6).

Table 6. Analyses of mortality data during heatwaves

Type of analysis	Descriptive analysis	Computation of excess mortality	Modelling of heat attributable mortality through epidemiological or similar models
Albania	X	-	-
Belgium	X	X	-
Cyprus	X	-	-
Denmark	-	X	X
France	-	X	-
Germany	X	-	X
Greece	-	X	-
Hungary	-	X	X
Italy	-	X	X
Malta	-	X	-
The Netherlands	-	X	-
Spain	-	-	X
Sweden	-	X	X

3.2.2 Monitoring heat-related morbidity during heatwaves

In 6 countries, NPHIs monitor heat-related morbidity during heatwaves (Table 7). In Greece, emergency room visits, ambulance calls and hospital admissions are monitored by another authority, separate from the NHPI. Greece is therefore not covered below. In France and Hungary the morbidity data is split according to disease type. Four out of five countries monitor morbidity on daily basis; in Hungary monitoring is done on weekly basis. In Albania, France, Italy and Spain the data is broken down by age; Italy and Spain also provide data split by gender.

Table 7. Morbidity data used to monitor impacts during heatwaves

Data type	Analysis	Cause (ICD10 code)	Temporal resolution	Geographical resolution	Data broken down by sex	Data broken down by age	Age groups (years)
Albania							
Ambulance calls	Descriptive only	All causes; Cardiovascular (ICD10 code: I00-I99)	Daily	Municipalities/other local division	Yes	Yes	No data provided
GP consultation	Descriptive only	All causes; Cardiovascular	Weekly	Municipalities/other local division	No	Yes	No data provided

Data type	Analysis	Cause (ICD10 code)	Temporal resolution	Geographical resolution	Data broken down by sex	Data broken down by age	Age groups (years)
		(ICD10 code: I00-I99)					
France[10]							
Emergency room visits	Descriptive only	All causes; Effects of heat and light (T67), Dehydration (E86), Hyponatraemia (E87)	Daily	Departmental	-	X	1-year intervals
GP consultations	Descriptive only	All causes; Effects of heat and light (T67), Dehydration (E86)	Daily	Main Cities (SOS médecins associations)	-	X	1-year intervals
Hungary[11]							
Ambulance calls	Descriptive only	Effects of heat and light (T67), Dehydration (E86), Cardiovascular (I00-I99), Renal (N17-N19)	Weekly	Country	-	-	n.a.
Italy[12]							
Emergency room visits	Computation of excess activity	All causes	Daily	Municipalities/local	X	X	0-64, 74-75, 75-84, 85+

[10] More information here: https://www.santepubliquefrance.fr/presse/2024/bilan-canicule-et-sante-un-ete-2023-marque-par-4-episodes-de-canicule-avec-un-impact-sanitaire-important

[11] No link or further information was provided on how Hungary monitors ambulance calls during heatwaves.

[12] More information here: https://www.salute.gov.it/portale/caldo/archivioPubblicazioniCaldo.jsp

Data type	Analysis	Cause (ICD10 code)	Temporal resolution	Geographical resolution	Data broken down by sex	Data broken down by age	Age groups (years)
GP consultations[13]	Computation of excess activity	All causes	Daily	Municipalities/local	X	X	Differs between regions
Malta[14]							
Emergency room visits - Ambulance calls - Hospital admissions - GP consultations	Computation of excess activity	All causes	Daily	Country	-	-	n.a.
Spain[15]							
Emergency room visits - Ambulance calls - Hospital admissions - GP consultations	No data provided	No data provided	Daily	Isoclimatic zones[16]	X	X	0-4, 5-64, 65+

3.3 Evaluation: assessing health impacts after heatwaves

11 countries stated that health impacts are evaluated after a heatwave to support long-term decision making (Table 8). Nine of ten countries evaluate mortality data; Romania only evaluates hospital admissions. Further, Austria, Hungary, Malta, Italy and Norway evaluate at least one morbidity aspect in addition to mortality.

Table 8. Type of health impacts data monitored after heatwaves

Country	Mortality data	Emergency room visits	Ambulance calls	Hospital admissions	GP consultations

[13] In Italy, active surveillance programs by GPs are put in place on regional level and data on consultations can be evaluated, but surveillance is only done for vulnerable subgroups of the elderly population during heat warnings.

[14] No link or further information was provided on how Malta monitors morbidity data during heatwaves.

[15] No description was provided on what type of analysis of morbidity data after heatwaves that is carried out. Further, the Spanish respondent referred to the regional government monitoring morbidity data but no links, contact details or further information was given.

[16] Spain has 182 such zones.

Austria[17]	x	-	-	x	-
Belgium	x	-	-	-	-
France	x	-	-	-	-
Germany	x	-	-	-	-
Hungary	x	-	x	-	-
Italy	x	x	-	-	x
Malta[18]	x	x	x	x	x
Norway	x	-	-	x	-
Romania	-	-	-	x	-
Sweden	x	-	-	-	-
Switzerland	x	-	-	-	-

Austria evaluates annual heat-attributable mortality using daily temperature readings from 181 measuring stations and by comparing the number of observed and statistically expected deaths in the country.[19] The available information dates back to 2016. In addition, heat-related hospital admissions (recorded under ICD10-code 'Effects of heat and light' (T67)) are analysed after heatwaves. Until now, no reports with this data, or methodological descriptions of how this data is collected, have been published.

In France, the fraction of mortality attributable to heat is quantified at the departmental level, using 1-year interval age groups, for the monitoring period of the heatwave and health alert system (1 June – 15 September).

In Germany, the annual number of heat-related deaths and excess mortality is quantified using weekly data on regional level and split by the following age groups: <=64, 65-74, 75-84, 85+. The results go back to 2012 (Robert Koch Institut, 2023a).

Evaluation of post-heatwave excess mortality in Hungary is done using daily mortality data on municipal level, broken down both by sex and age (<65y, >65y) (Mašfelfok, 2019). In a study from 2014, it was estimated that a 5ºC increase in the daily mean temperature increases the risk of all-cause mortality by 10% and the risk of death due to cardiovascular diseases by 12% (Paldy and Jones, 2010).

Appendix 2 provides examples of methods for monitoring and evaluating impacts during and after heatwaves.

3.4 Reporting and disseminating of monitoring results

Nearly all of the 13 countries that monitor the health impacts **during heatwaves**[20] report the results to both decision-makers and the general public. Cyprus and Greece do not make this data publicly available. Disseminating the results is done either through publishing reports, press releases, or by presenting the data via interactive webpages as is done in Belgium and Germany.

[17] Analysis of mortality data is conducted by the Austrian Agency for Health and Food Safety GmbH

[18] No link or further information was provided on how Malta monitors mortality or morbidity data after heatwaves

[19] More information about the modelling method can be found here: https://www.ages.at/en/environment/climate/climate-change-adaptation/heat

[20] Belgium, Cyprus, France, Germany, Greece, Hungary, Italy, Malta, The Netherlands, Spain, Sweden

The temporal scale of reporting differs, but most countries provide results on a weekly basis both to decision makers and the public. Reporting to decision-makers is done daily in Malta and France and nearly daily in the Netherlands. When providing information to the general public, results are reported during heatwave alerts (Hungary, Sweden) and at the end of a heatwave (the Netherlands), annually (Spain) and periodically (Malta)[21].

Eight of the 11 countries that publicly disseminate the results use a dedicated webpage for this purpose. The remaining three – Malta, Sweden, and Spain – share the results via press releases (Malta) or through an online database (Sweden and Spain). France provides both a webpage and database. Further, in five countries – France, Germany, Hungary, Italy and Sweden – the results are published later through a scientific paper.

For reporting on heat-related health impacts **analysed after heatwaves**, all 13 countries that perform such analyses[22] disseminate the result publicly using different methods (Table 9) according to the approach listed in
Table 10.

Table 9. Dissemination of results after heatwaves

Approach	Countries
Dedicated webpage	Austria, Belgium, Denmark, Italy, Norway, Romania, Sweden
Scientific paper	France, Germany, Greece, Sweden
Press release	Malta

Most of the surveyed countries publish heat-health impact evaluations on an annual basis to inform decision makers and the public. Other reporting intervals are used in Austria, Sweden, and Norway, who inform decision-makers when required and/or as necessary, and Romania where the decision-makers are informed quarterly (but the general public is informed annually). Further, Sweden and Norway inform the public only when a heat event has occurred, and Malta only makes results publicly available via press releases on an unspecified basis.

[21] Intervals not defined in submitted response

[22] Austria, Belgium, France, Germany, Hungary, Italy, Malta, Norway, Romania, Sweden

4. Heat-health action plans

Out of all 28 responding countries, 15 stated that they either have a heat-health action plan in place (12 countries), or that such a plan is under development (three countries). HHAPs are currently more common in south-western Europe (Map 3) and the countries that have not published an action plan are to a very high degree the same countries that do not currently monitor heat related health-impacts (see Map 1).

Map 3. Countries with a heat-health action plan

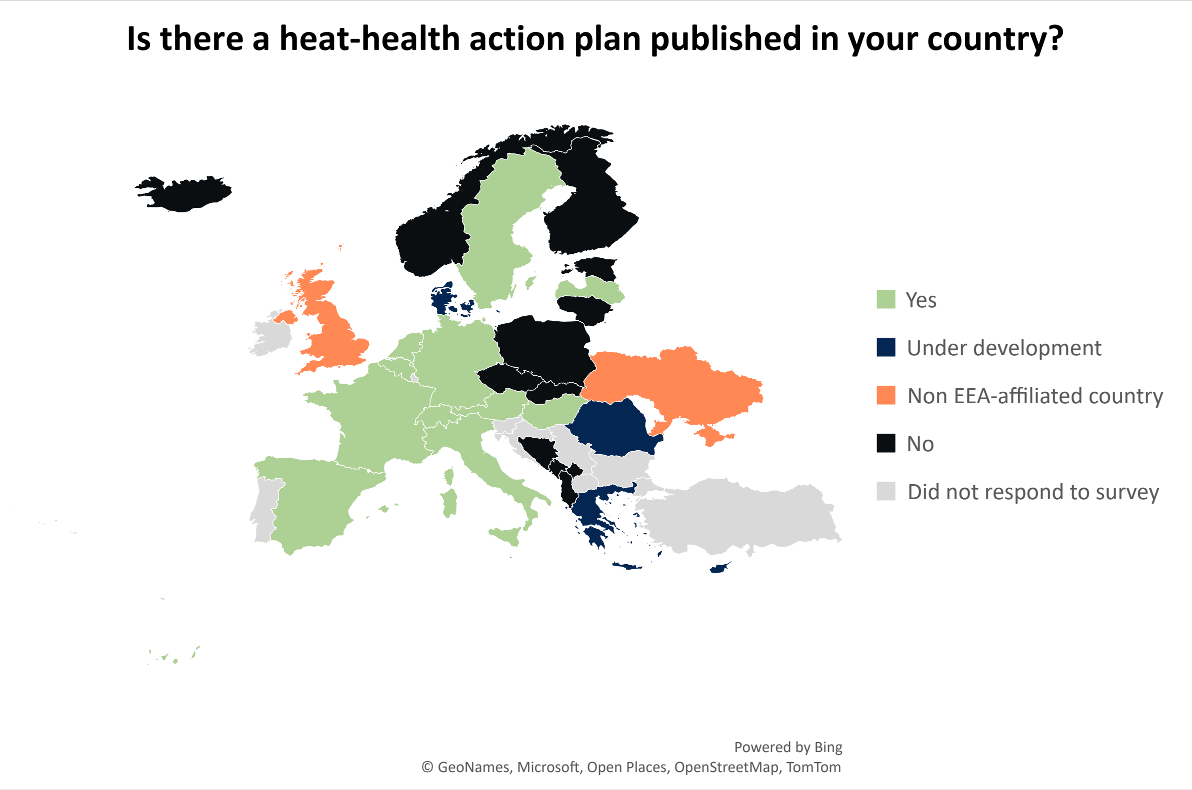


Table 10. Governance level of heat-health action plans shows the governance levels at which the plan is implemented. While the survey does not provide detailed information on the coverage of local and regional action plans, some additional insights can be drawn from open answers:

- For **Belgium**, plans exist for the Flemish, Walloon, and Brussels regions. Initially managed by the Federal Government, the plan's implementation shifted to regional authorities following the 6th state reform
- In **Hungary**, the only other country that has a plan but not a general plan on national level, specific (national) plans have been developed for certain groups/sectors, including for social and child welfare institutions.
- In **Italy**, the regions have developed their own plans.
- In the **Netherlands**, more than 40 cities have local action plan

0 provides more detail about the selected HHAPs at different governance levels in Europe

Table 10. Governance level of heat-health action plans

Countries	National	Regional	Local	Other
Austria	x	x	x	-
Belgium	x	x	-	-
France	x	-	x	-
Germany	x	-	-	-
Hungary	-	-	-	x
Italy	x	x		
Latvia	x	-	-	-
The Netherlands	x	-	x	-
Malta[23]	x	-	-	-
Spain	x	x	-	-
Sweden	x	x	x	-
Switzerland	-	-	x	-

[23] *Malta's HHAP is not publicly available.*

5. Conclusions

Just over half of the surveyed countries perform monitoring of heat-related health impacts, and just under half have heat-health action plans in place. Heat health action plans are more common in countries that monitor heat-related health impacts. Overall, the levels of preparedness to heat vary across Europe and requires strengthening.

There is considerable diversity in monitoring practices across different countries, in terms of both when and how monitoring is conducted, and for what purpose. This diversity not only reflects a variety of approaches for monitoring impacts but also underscores the potential for cross-national learning and collaboration towards improved monitoring strategies across Europe. In particular, the opportunity for less advanced countries to gain insights and build capacity from existing approaches and practices should be considered. Dedicated networks and platforms, including the European Climate and Health Observatory and the IANPHI committee on climate change and health, can facilitate knowledge transfer.

Further, there is an opportunity to develop a harmonised reporting framework at EU level, building on the countries' ongoing heat mortality monitoring and the existing mortality monitoring activities such as EuroMomo. Such a framework could complement existing national efforts, providing a consistent and standardised approach to monitoring heat-related health impacts in European countries. It would also enhance the overall quality of data collected and facilitate more accurate comparisons between countries.

6. Limitations

The factors that could impact the validity of the findings presented in this report are as follows:

- First, the questionnaire was rather complex with many questions for the respondents to answer. As a result of the questionnaire design, there could be an increased risk of participants becoming fatigued or disengaged.
- Provision of the questionnaire in English language could have lead to misunderstanding of questions and inaccurate responses.
- The difference between 'monitoring during the heatwaves' and 'analysis after the heatwaves' is quite subtle and it appears some of the respondents provided very similar answers to the questions regarding monitoring of impacts *during* heatwaves and those regarding evaluating impacts *after* heatwaves.
- In several instances, responses were not backed up by evidence to further explain, clarify and/or validate answers provided. This report presents the data as it has been reported by respondents, but we have highlighted cases where no or very limited evidence for a certain response has been provided.
- Due to time constraints, the findings were not validated and contextualised through follow-up interviews. Thus, for certain parts of the analysis, uncertainties remain regarding the submitted answers

7. References

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Appendix 1.

Survey questionnaire

On behalf of which country are you replying?

Please provide your contact email:

_____

By selecting this box you accept to be contacted and that your email will be shared with EEA and IAPNHI representatives involved in the project (optional)

(1) ❑

Is your NPHI currently monitoring (including near-real-time monitoring, and/or monitoring and evaluation, and/or forecasting) any heat-related health impacts (morbitidy and/or mortality)?

(1) ❍ Yes
(2) ❍ No
(3) ❍ Under development

Can you please provide the reason

(3) ❍ Heat is not in the scope of the NPHIs focus.
(1) ❍ Heat has not been identified as a priority in the NPHI's working plan.
(2) ❍ There is currently no data available to the NPHI to carry out such monitoring

Please explain the current status of the development

____
____
____
____
____
____

During which period(s) of the year does your NPHI carry out heat monitoring?

(1) ❍ All year round
(2) ❍ During specific period only (please specify) _____

What are the definitions regarding heat and heat waves used for your NPHI's monitoring?

How do you define heat?	_____
How do you define heat waves?	_____

Forecasting

This section focuses on predicting expected heat-related health impacts based on weather forecasts. The subsequent sections will focus on monitoring the heat-related health impacts based on observable data, to support rapid and long term decision making.

Do you predict the health impacts (mortality and/or morbidity) based on weather forecasts?

(1) ❍ Yes (please specify the health outcomes and provide a link to document further describing the model, if available) _____
(2) ❍ No

Do you consider any of the following air pollution data in the heat risk and health impact forecasting? (please select all that apply)

(1) ❑ Particulate Matter (PM) (e.g. PM 2.5 and PM10)
(2) ❑ Ozone
(3) ❑ NO2
(4) ❑ Dust (e.g. desert dust)
(5) ❑ None
(6) ❑ Other (please specify): _____

Surveillance during heat waves to support rapid decision making

The questions in this section concern your surveillance approaches before, during and immediately after a heat wave, to support decision-making. This can include estimating the health impacts based on forecasted temperatures, near real-time monitoring (data available within 1 week after a heat wave), and rapid reporting (data available between 1 week and 1 month after a heat wave).

Following this section there will be other specific sections on analyses that are done after the end of a heat wave to support longer term decision making.

Do you conduct surveillance of heat-related health impacts (morbidity and/or mortality) during a heat wave to support rapid decision making?

(1) ❍ Yes
(2) ❍ No

For how long has your NPHI regularly monitored real-time heat-related health impacts (morbidity and/or mortality)?

(1) ❍ Less than 1 year
(2) ❍ 1-5 years
(3) ❍ 6-10 years
(4) ❍ More than 10 years

Which type of health data do you use for the surveillance of heat-related impacts to support rapid decision making?
Please check all that apply.

	All-causes	Non-accidental causes	Hyperthermia (ICD10 code: T67)	Dehydration (ICD10 code: E86)	Cardiovascular (ICD10 code: I00-I99)	Respiratory (ICD10 code: J00-J99)	Renal (ICD10 code: N17-N19)	Neurological (ICD10 code: G00-G99)	Other (if possible, include ICD10 code):	Not monitored
Mortality data	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑	(8) ❑	(9) ❑ ______	(10) ❑
Emergency room visits	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑	(8) ❑	(9) ❑ ______	(10) ❑
Ambulance calls	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑	(8) ❑	(9) ❑ ______	(10) ❑
Hospital admissions	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑	(8) ❑	(9) ❑ ______	(10) ❑
GP consultations	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑	(6) ❑	(7) ❑	(8) ❑	(9) ❑ ______	(10) ❑

Other (please specify):

_____

Regarding <u>mortality data</u> used <u>during</u> a heat wave

(2) ❍ Yes, mortality data is used during a heat wave
(1) ❍ No, mortality data is not used during a heat wave

Regarding **<u>mortality data</u>** used <u>during</u> a heat wave

What is the smallest temporal resolution of data?

(1) ❍ Daily
(2) ❍ Weekly
(3) ❍ Montly
(4) ❍ Other (please specify): _____

What is the smallest geographical resolution of data used?

(1) ❍ Country
(2) ❍ Regional/country
(3) ❍ Municipalities/other local division
(4) ❍ Other (please specify): _____

Is the data used broken down by sex?

(1) ❍ Yes
(2) ❍ No

Is the data used broken down by age groups?

(0) ❍ Yes (please specify age groups) _____
(1) ❍ No

What type of analysis of mortality data is carried out at your NPHI during a heat wave?

(1) ❑ Descriptive only
(2) ❑ Computation of excess mortality (please provide a link to the method used, if available) _____
(3) ❑ Modeling of heat attributable mortality through epidemiological or similar models (please provide a link to the method, if available) _____
(4) ❑ Other (please specify): _____

Are there any reports about the analysis, methods and/or results published by your NPHI? (if possible, please provide links)

_____

Regarding data on <u>emergency room visits</u> used to monitor morbidity <u>during</u> a heat wave

(2) ❍ Yes, data on emergency room visits is used during a heat wave
(1) ❍ No, data on emergency room visits is not used during a heat wave

Regarding data on **<u>emergency room visits</u>** used to monitor morbidity <u>during</u> a heat wave

What is the smallest temporal resolution of data used?

(1) ❍ Daily
(2) ❍ Weekly
(3) ❍ Montly
(4) ❍ Other (please specify): _____

What is the smallest geographical resolution of data used?

(1) ❍ Country
(2) ❍ Regional/country
(3) ❍ Municipalities/other local division

(4) ❍ Other (please specify): _____

Is the data used broken down by sex?
(1) ❍ Yes
(2) ❍ No

Is the data used broken down by age groups?
(0) ❍ Yes (please specify age groups) _____
(1) ❍ No

What type of analysis of emergency room visits data is carried out at your NPHI during a heat wave?
(1) ❑ Descriptive only
(2) ❑ Computation of excess number of emergency room visits (please provide a link to the method, if available) _____
(3) ❑ Modeling of attributable fraction to heat (please provide a link to the method, if available) _____
(4) ❑ Other (please specify): _____

Are there any reports about the analysis, methods and/or results published by your NPHI? (if possible, please provide links)
_____

Regarding data on <u>ambulance calls</u> used to monitor morbidity <u>during</u> a heat wave
(2) ❍ Yes, data on ambulance calls is used during a heat wave
(1) ❍ No, data on ambulance calls is not used during a heat wave

Regarding data on <u>**ambulance calls**</u> used to monitor morbidity <u>during</u> a heat wave

What is the smallest temporal resolution of data used?
(1) ❍ Daily
(2) ❍ Weekly
(3) ❍ Montly
(4) ❍ Other (please specify): _____

What is the smallest geographical resolution of data used?
(1) ❍ Country
(2) ❍ Regional/country
(3) ❍ Municipalities/other local division
(4) ❍ Other (please specify): _____

Is the data used broken down by sex?
(1) ❍ Yes
(2) ❍ No

Is the data used broken down by age groups?

(0) ❍ Yes (please specify age groups) _____
(1) ❍ No

What type of analysis of ambulance call data is carried out at your NPHI during a heat wave?

(1) ❑ Descriptive only
(2) ❑ Computation of excess number of ambulance calls (please provide a link to to the method, if available) _____
(3) ❑ Modeling of attributable fraction to heat (please provide a link to to the method, if available) _____
(4) ❑ Other (please specify): _____

Are there any reports about the analysis, methods and/or results published by your NPHI? (if possible, please provide links)

_____

Regarding data on GPs consultations used to monitor morbidity during a heat wave

(2) ❍ Yes, data on GPs consultations is used during a heat wave
(1) ❍ No, data on GPs consultations is not used during a heat wave

Regarding data on **GP consultations** used to monitor morbidity during a heat wave

What is the smallest temporal resolution of data used?

(1) ❍ Daily
(2) ❍ Weekly
(3) ❍ Montly
(4) ❍ Other (please specify): _____

What is the smallest geographical resolution of data used?

(1) ❍ Country
(2) ❍ Regional/country
(3) ❍ Municipalities/other local division
(4) ❍ Other (please specify): _____

Is the data used broken down by sex?

(1) ❍ Yes
(2) ❍ No

Is the data used broken down by age group?

(0) ❍ Yes (please specify age groups) _____
(1) ❍ No

What type of analysis of GPs consultations data is carried out at your NPHI during a heat wave?

(1) ❑ Descriptive only
(2) ❑ Computation of excess number of GPs consultations (please provide a link to the method, if available) _____
(3) ❑ Modeling of attributable fraction to heat (please provide a link to the method, if available) _____
(4) ❑ Other (please specify): _____

Are there any reports about the analysis, methods and/or results published by your NPHI?
(if possible, please provide links)

_____

Regarding data on <u>hospital admissions</u> used to monitor morbidity <u>during</u> a heat wave

(2) ❍ Yes, data on hospital admissions is used during a heat wave
(1) ❍ No, data on hospital admissions is not used during a heat wave

Regarding data on **<u>hospital admissions</u>** used to monitor morbidity <u>during</u> a heat wave

What is the smallest temporal resolution of data used?

(1) ❍ Daily
(2) ❍ Weekly
(3) ❍ Montly
(4) ❍ Other (please specify): _____

What is the smallest geographical resolution of data used?

(1) ❍ Country
(2) ❍ Regional/country
(3) ❍ Municipalities/other local division
(4) ❍ Other (please specify): _____

Is the data used broken down by sex?

(1) ❍ Yes
(2) ❍ No

Is the data used broken down by age group?

(0) ❍ Yes (please specify age groups) _____
(1) ❍ No

What type of analysis of hospital admissions data is carried out at your NPHI during a heat wave?

(1) ❑ Descriptive only
(2) ❑ Computation of excess number of hospital admissions (please provide a link to the method, if available) _____

(3) ❑ Modeling of attributable fraction to heat (please provide a link to the method, if available) _____
(4) ❑ Other (please specify): _____

Are there any reports about the analysis, methods and/or results published by your NPHI?
(if possible, please provide links)

_____

Regarding communication of monitoring results <u>during</u> heat waves

Who are the intended readers of your NPHI's monitoring results? (please check all that apply)

(1) ❍ Ministry of health
(2) ❍ Health professionals
(3) ❍ General population/media
(4) ❍ Other (please specify): _____

How often do you report the results of your NPHI's analysis to <u>decision-makers</u>?

(1) ❍ Daily
(2) ❍ Weekly
(3) ❍ Never
(4) ❍ Other (please specify): _____

How often do you report the results of your NPHI's analysis to the <u>general population</u>?

(1) ❍ Daily
(2) ❍ Weekly
(3) ❍ Never
(4) ❍ Other (please specify): _____

How do you report the results?

(1) ❑ Dedicated website (please share link) _____
(2) ❑ Scientific paper (please share link) _____
(3) ❑ Online database (please share link) _____
(4) ❑ Results are not public

Is there a heat-health action plan published in your country?

(1) ❍ Yes
(2) ❍ No
(3) ❍ Under development

At what level(s) have heat-health action plans been developed in your country?

(1) ❑ National level (please provide link): ______
(2) ❑ Regional level (please provide links): ______
(3) ❑ At city/local level (please provide links): ______
(4) ❑ Other (please provide links): ______

Would you agree to be contacted for a further interview?

(1) ❍ Yes (please provide your name and email address; name surname, email): ______
(2) ❍ No

Examples of methods for monitoring and evaluating impacts during and after heatwaves

Belgium

The Belgian Mortality Monitoring (Be-MOMO) model tracks all-cause mortality with an emphasis on deaths due to extreme environmental conditions. The model uses weekly mortality data from the National Register, supplemented with environmental data (e.g. temperature, air quality) from the Royal Meteorological Institute and the Belgian Interregional Environment Agency. The data is smoothed using a 7-day moving average, allowing for a clear comparison of observed deaths against expected values based on historical data.

The Be-MOMO model employs a modified Poisson model, integrating seasonal patterns to predict expected mortality. Significant excess mortality is flagged when observed deaths surpass the model's prediction intervals, often indicating the impact of heatwaves. This method not only identifies mortality peaks associated with heatwaves but also provides a historical context, analysing past events like the heatwaves in August 2020 and the summer of 2022. This provides a knowledge basis for developing public health strategies to mitigate future heatwave impacts.

France

In France, the Santé Publique France method focuses on monitoring health impacts during heatwaves through a comprehensive surveillance system activated during orange weather alerts, the middle of a three-tier alert system (yellow, orange, red; green represents normal weather). This system tracks emergency service (ambulatory and emergency room contact) indicators such as cases of hyperthermia and dehydration, providing real-time data on health impacts. Thanks to this monitoring method it has been recognised that emergency visits and hospitalizations increase significantly during heatwaves, particularly among vulnerable populations like the elderly and children. The system's data is vital for timely public health interventions, ensuring that preventive measures are promptly adjusted to minimize health risks.

While the system provides immediate insights into morbidity, a more comprehensive analysis of excess mortality is typically conducted a month after a heatwave event. An example is the analysis of the impacts of the summer of 2023 conducted by Sante Publique France (2023) where there were a total of four heatwaves, 20,000 emergency department visits for heat illnesses during summer and 5,000 deaths attributable to heat, 1,500 during heat waves.

Germany

Germany's method for estimating heatwave-related mortality involves a detailed analysis of weekly all-cause mortality data, categorized by age groups and federal states (Robert Koch Institut, 2024b). This data, along with temperature information from the German Weather Service, is analysed using a Generalized Additive Model (GAM). The model identifies temperature thresholds for different demographic groups, marking weeks with temperatures above these thresholds as "heat weeks." This approach allows for a clear understanding of the impact of heatwaves on mortality rates.

The analysis reveals that significant excess mortality often occurs during heatwaves, with notable variations across regions and age groups. Over the past three decades, data indicates some adaptation to heat, as reflected in a slight decline in heat-related mortality. This trend underscores the importance of adaptive measures and public health interventions to protect vulnerable populations, particularly during extreme weather events.

Italy

Italy's SiSMG system, established in 2004, serves as a national daily mortality surveillance system focused on temperature-related mortality, particularly during heatwaves. The system collects data from municipal registry offices, providing near-real-time insights into mortality trends. Weekly reports compare observed deaths with a baseline average derived from historical data, allowing for the detection of unusual mortality patterns during heatwaves.

SiSMG categorizes mortality data by age groups and produces detailed seasonal reports, highlighting the impact of temperature variations on mortality. During heatwaves, the system's reports include specific alerts and analyses, supporting public health interventions. The SiSMG data is integrated into the European mortality surveillance network EuroMOMO.

The Netherlands

In the Netherlands, the National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieu (RIVM)) estimates heatwave-related mortality by analysing weekly mortality data in conjunction with temperature data from Statistics Netherlands. A segmented linear model is used to understand the relationship between temperature fluctuations and mortality, particularly focusing on temperatures above certain thresholds. The analysis identified that during the period of July 2024 daily average temperatures above 22°C were associated with increased mortality rates, with the elderly and residents in low-income or less densely populated areas being particularly at risk.

The National Heatwave Plan, developed in collaboration with the Royal Netherlands Meteorological Institute (KNMI), activates during heatwaves to ensure preparedness and protect vulnerable groups. This plan involves alerting healthcare organizations and other relevant bodies, facilitating timely interventions. The comprehensive approach underscores the importance of targeted public health strategies to mitigate the effects of extreme heat, which are expected to increase with climate change.

Examples of heat-health action plans

Belgium

The Belgian Heat Action Plan, established in 2005, integrates both temperature and ozone criteria to mitigate public health risks during extreme heat events. Initially managed by the Federal Government, the plan's implementation shifted to regional authorities following the 6th state reform. The plan operates under the National Environmental Health Action Plan (NEHAP) and involves coordination between federal, regional, and community services. The plan includes a vigilance phase, where professionals working with vulnerable groups are alerted to prepare for potential heatwaves, and a warning phase, which is activated based on specific temperature predictions.

The Flemish Heat Action Plan, a component of the national plan, focuses on informing and preparing vulnerable groups and professionals. The vigilance phase, from May 15 to September 30, involves monitoring temperature forecasts and ozone concentrations. The warning phase is triggered when the predicted cumulative temperature exceeds a certain threshold, giving organizations time to implement protective measures. The Federal Alarm Phase, considered a crisis phase, is activated under more severe conditions, requiring additional measures and coordinated communication efforts by federal and regional authorities.

France

The French heat action plan, produced by Santé publique France, focuses on managing and mitigating the health risks associated with heat waves. Key features include a Heat Wave and Health Alert System, known as Sacs, which monitors weather conditions and health impacts. This system has a meteorological component managed by Météo-France and a health component overseen by Santé publique France. It operates from June 1 to September 15, with daily updates and vigilance levels provided to the Santé publique France from the national weather system categorized into yellow (short-term or persistent heat exposure), orange (heatwave with significant health risks), and red (extreme heat wave with severe health impacts).

The plan emphasizes protecting vulnerable populations, such as the elderly, children, pregnant women, and those with health conditions or working in high-heat environments. Preventive measures include widespread dissemination of information and guidelines to health professionals, institutions, and the public. During heightened vigilance periods, additional resources like social media campaigns, radio spots, and TV broadcasts are employed to raise awareness and guide the public on staying safe. This comprehensive approach ensures that the population, especially the most at risk, receives timely and actionable information to minimize heat-related health issues.

Germany

Germany's heat protection plan was established to mitigate the health impacts of heatwaves, exacerbated by climate change. The plan, initiated by the Federal Ministry of Health (BMG), emphasizes the necessity of a coordinated approach across federal, state, and local levels, and incorporates lessons learned from France's national heat protection plan. The primary objectives are to raise public awareness, especially among vulnerable groups, reduce heat-related fatalities and illnesses, and initiate timely interventions based on specific heat warning systems.

To protect vulnerable populations such as the elderly, children, and those with pre-existing health conditions, the plan proposes several targeted measures. These include disseminating information to nursing homes, encouraging the development of heat protection plans, and promoting the appointment of heat coordinators in healthcare facilities. The plan also involves expanding public education campaigns, using tools like the Heat Service Portal to provide practical advice, and strengthening community-based support systems, such as neighbourhood assistance programs. Additionally, the BMG plans to work with health insurance providers and local governments to enhance preventive measures and improve the accessibility of resources for those at risk.

Hungary

The Hungarian heat action plan is designed to provide a proactive approach to mitigate the health impacts of increasing heatwaves under climate change. Managed by the National Public Health and Pharmaceutical Centre, the plan includes a heat alarm system that categorizes alerts into three levels based on temperature forecasts: Level 1 for average temperatures above 25°C, Level 2 for sustained average temperatures over 27°C for three consecutive days, and Level 3 for extreme conditions with average temperatures consistently above 30°C. These alerts prompt coordinated responses from healthcare providers, local governments, and social institutions to protect public health, particularly among vulnerable populations such as the elderly, those with chronic diseases, and socially isolated individuals.

To support these vulnerable groups, the plan emphasizes several key actions. These include improving building infrastructure to manage heat, such as installing external shading, using air conditioning, and maintaining indoor temperatures below 26°C in critical care areas. Social institutions are advised to ensure continuous monitoring of vulnerable individuals, provide adequate hydration, and consider the potential impacts of certain medications that can increase heat sensitivity. Additionally, the plan encourages the use of natural cooling methods, such as increasing green spaces and using reflective paints, to enhance sustainability and reduce reliance on air conditioning, which can contribute to urban heat island effects. The plan also includes public education on heat-related illnesses and practical steps to prevent them, such as wearing light clothing, staying hydrated, and avoiding strenuous activities during peak heat periods.

Italy

The Italian National Heat Action Plan is designed to mitigate the health risks associated with extreme heat events, particularly for vulnerable populations such as the elderly, individuals with chronic diseases, outdoor workers, and socially isolated individuals. The plan integrates scientific evidence with practical interventions, emphasizing a coordinated approach among various stakeholders. Central to this strategy is the implementation of Heat Health Watch Warning Systems (HHWWS) across major cities. These systems provide early warnings through bulletins issued by the national weather agency up to 72 hours in advance, forecasting health risks based on meteorological data. The HHWWS categorizes risk levels, prompting specific actions such as public information campaigns, special measures for at-risk groups, and readiness protocols in healthcare facilities.

To address these risks, the plan outlines specific thresholds and corresponding actions for government and public agencies. For instance, at lower risk levels, the focus is on public education, ensuring that communities are aware of heat risks and prevention strategies. As risk levels escalate, more proactive measures are taken, such as the activation of local support systems to check on vulnerable individuals, provision of cooling centres, and the mobilization of healthcare resources to manage heat-related illnesses. In cases of severe heatwaves, the plan calls for emergency responses, including increased monitoring of health data, enhanced hospital readiness, and coordination with social services to assist the elderly and those with chronic health conditions. These actions are designed to minimize heat-related morbidity and mortality, ensuring a swift and effective public health response to protect those most at risk.

Sweden

The Swedish Heat Action Plan outlines essential strategies for municipalities, regions, and private entities to manage and mitigate the health impacts of heatwaves, focusing particularly on vulnerable groups such as the elderly, chronically ill, children, pregnant women, and individuals on specific medications. Key to this plan is the establishment of temperature thresholds that trigger public health warnings and actions. Notifications are issued when daily maximum temperatures are expected to reach 26-30°C for three consecutive days, serving as an early alert. More severe warnings, such as yellow and orange alerts, are activated at 30°C and 33°C respectively, indicating critical heat conditions that necessitate immediate protective measures.

To safeguard vulnerable populations, the plan emphasizes proactive communication and support. Municipalities are tasked with disseminating clear information through various channels, advising the public on how to stay safe during heatwaves. This includes practical advice for cooling strategies and recognizing symptoms of heat-related illnesses. Special attention is given to the elderly and chronically ill, who may require assistance with staying hydrated and maintaining a safe body temperature. Healthcare providers are encouraged to review and adjust medications that could increase heat sensitivity, ensuring these individuals receive the necessary support.

Kristianstad municipality's Heat Action Plan addresses the growing risks associated with heatwaves, which are becoming more frequent due to climate change. The plan aims to mitigate the impact of extreme heat on public health and infrastructure by implementing preventive measures, crisis management strategies, and effective communication. It stresses the importance of updating protocols annually, particularly for vulnerable groups such as the elderly, chronically ill, and individuals with specific health conditions. The plan underscores the necessity of timely and targeted information dissemination to ensure that those at risk receive appropriate warnings and advice.

A key element of the plan is the identification and support of vulnerable populations. It establishes specific actions and thresholds that local governments monitor via the national alert system, such as activating cooling centres when daily maximum temperatures exceed 26°C for three consecutive days, and prioritizing these groups for additional care and monitoring. The plan advises reducing physical exertion, staying hydrated, and using cooling methods like air conditioning or shaded rest areas. Healthcare providers are instructed to monitor for signs of heat-related illnesses, such as heat exhaustion and heatstroke, particularly in individuals with pre-existing conditions. The plan also includes detailed checklists for healthcare, social services, and educational institutions to ensure comprehensive preparedness and response during heatwaves.