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National Plan for preventive actions for the effects of excess temperature on health

Year 2023

NATIONAL PLAN OF PREVENTIVE ACTIONS FOR THE EFFECTS OF EXCESS OF TEMPERATURES ON HEALTH 2023 approved by the Interministerial Commission for the effective application of the National Plan for Preventive Actions on the Effects of Excess Temperatures on Health at its meeting on April 17, 2023.

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Foreword

The association between high temperatures and increases in morbidity and mortality is very robust, numerous epidemiological studies show a significant increase in mortality above a certain thermal threshold, and it has been shown that extremely high temperatures directly affect mortality from cardiovascular diseases and respiratory.

During the summer months of 2003, very high temperatures occurred throughout Europe, which caused a significant increase in morbidity and, as has subsequently been proven, in mortality due to causes in which the excess temperature factor was a factor. trigger. This fact highlighted the importance of high temperatures on public health.

In order to avoid episodes such as those that occurred during that year, in 2004 Spain began the ***National Plan for Preventive Actions for the Effects of Excess Temperatures on Health,*** with the aim of reducing the potential effects associated with high temperatures during the year. summer period. Since its launch, the National Plan has included improvements over the years, generating a positive impact in relation to the prevention of problems and diseases related to exposure to excessive temperatures.

This is the ***nineteenth year*** that the Ministry of Health plans and manages the National Plan and its relevance as an instrument for preventing the effects of high temperatures on health is undoubted, since experts predict that heat waves will increasingly occur. more frequent and will last longer due to climate change.

As every summer, the Ministry of Health makes information available to health authorities and citizens regarding the effects of high temperatures on health, as well as the daily risk levels due to excess temperatures during the summer period, with the aim to prevent the effects of high temperatures on health.

Pilar Aparicio Azcárraga

General Director of Public Health

Background

During the summer months of 2003, very high temperatures occurred throughout Europe, which caused a significant increase in morbidity and, as has subsequently been proven, in mortality due to causes in which the excess temperature factor was a trigger. In order to avoid episodes like those that occurred during that summer, in 2004 the Ministry of Health launched
the **National Plan of Preventive Actions for the Effects of Excesses of Temperatures About Health.** Since then, the National Plan is activated every summer during the months of June to September.

The application of the National Plan is fulfilling its main objective: the prevention of health damage caused by excess temperature. From a health perspective, exposure to excessive temperatures especially affects minors, the elderly and people with underlying chronic pathologies. From a social point of view, marginalization, isolation, dependency, disability, the living conditions of people with fewer resources, add risk factors that make groups that, precisely because of their socio-economic conditions, even more vulnerable. , they should be more supported.

The implementation of the National Plan is having a positive impact in relation to the prevention of problems and diseases related to exposure to excessive heat. In general terms, the population has been informed about how to protect themselves and care for people at higher risk, avoiding problems for the most unprotected groups.

The design and development of meteorological and mortality information systems has been a key part of the Plan's success. One of the results worth highlighting is the execution of a Mortality Information and Analysis System that allows monitoring of daily mortality, very useful for the rapid detection of other problems.
of health.

The National Plan establishes measures to reduce the effects associated with excessive temperatures and to coordinate the State Administration institutions involved. Likewise, it proposes actions that can be carried out by the Autonomous Communities and the Local Administration.

The National Plan establishes the actions planned for prevention and control, structured into several levels of action according to the level of risk reached as a consequence of the increase in temperatures. In addition, it proposes the collection of predictive information on environmental temperature and daily information on the

quantitative changes in mortality and establishes the criteria of the information system that allows active surveillance of the risks associated with exposure to excessive temperatures.

The results of mortality monitoring obtained in the years of validity of the National Plan also allow us to identify excess mortality even before it exceeds the risk thresholds due to temperature increases established in successive summer campaigns. To do this, in 2023, as in previous summers, mechanisms will be put in place to establish warning signals that indicate excess mortality associated with high temperatures.

An important aspect of this National Plan is the involvement with Social Services, since older people are the most vulnerable. The participation of administrations at both the central, regional and local levels, of social organizations and, above all, raising awareness and supporting the most sensitive groups, is essential to avoid damage to the population to the greatest extent possible. Another essential element is information to citizens, the highest risk groups and health and social services professionals.

The experience acquired during the years of execution of the National Plan since 2004 has made it possible to detect the necessary changes to improve its effectiveness. In 2015, an evaluation of the National Plan from 2004 to 2014 was carried out. This made it possible to identify aspects that should be improved and that would guarantee compliance with the health objectives of the Plan. In this sense, information and communication to citizens was improved, through convergence in risk levels due to excess temperatures throughout the Spanish territory [1].

Along the same lines, and in order to maximize exposure to natural heat
excessive, as well as warning indications for the population, in 2017 it was agreed to start a Pilot Plan whose geographical disaggregation scope would be established based on zones
isothermal. The definition of the isothermal zones was carried out through the zones of
weather prediction defined by the State Meteorological Agency [2]. This Pilot Plan will be executed in parallel with the National Plan throughout the Spanish territory in the coming years.

In order to take into consideration the most recent temperature data, as well as its possible evolution due to climate change, during this season the temperature thresholds for the provincial capitals have been adjusted based on a more current series of temperatures that have into consideration the aforementioned aspects. Likewise, the decision algorithm for issuing alerts for excess temperatures has been updated based on current scientific evidence.

Climate Change and Extreme Temperatures

During the last decades, concern has increased about the effects of “Climate Change” that has materialized in the United Nations Framework Convention, in the Kyoto Protocol and in the agreement reached at the Paris summit (COP21, December 2015).

The latest conclusions of the working groups of the Intergovernmental Panel on Climate Change (IPCC) continue to show that the observed global warming due to climate change is unequivocal, that the impacts of climate change are already negatively influencing many systems physical and biological, and that these effects will increase. Furthermore, they state that it is indisputable that human activities contribute to climate change, making extreme events, such as heat waves, torrential rains and droughts, more frequent and severe. Continued global warming caused by increasing concentrations of greenhouse gases in the atmosphere will have a broad and significant impact on the economy, environment and health. The projected effects due to climate change are very varied, affect a wide spectrum of ecological systems and socioeconomic sectors and are unevenly distributed across different territories and different regions. The Mediterranean region has

identified as one of the most vulnerable areas to climate change.

In order to improve and strengthen the capacity of the health sector to face the fight against climate change, the Ministry of Health and the Ministry for the Ecological Transition and the Demographic Challenge, have been developing instruments for analysis, diagnosis, evaluation, adaptation and monitoring the impacts of climate change on health and the National Health System, evaluating scenarios and models, to help decision-making, prioritize problems and propose adaptation and mitigation actions.

In light of current scientific knowledge, forecasts indicate an increase in the frequency and intensity of intense heat events. Although there is currently no internationally agreed definition of these episodes, it is accepted that this phenomenon is associated with abnormally high maximum and minimum temperatures with respect to the period considered, and its persistence over time.

The Spanish territory presents significant geographical variability that must be taken into account when proposing and applying health control and protection measures. The establishment of threshold temperatures and the assignment of levels are the basic elements for the characterization of the phenomenon of excessive temperatures, and both elements have been established jointly and in a flexible manner.

by the Ministry of Health and the State Meteorological Agency (Ministry for the Ecological Transition and the Demographic Challenge), taking into account the contributions made by the Autonomous Communities. The adaptation mechanisms of the population to excessive temperatures pointed out by the latest studies make it necessary to periodically review these thresholds [3].

According to the projections of the sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC), changes in the climate will occur throughout the 21st century, among which it is worth highlighting, at the European regional level:

- Temperatures will continue to increase at a faster rate than the global one. • Extreme warm events will increase in frequency, unlike extreme cold events.
- Sea level will continue to rise at a rate similar to the global one.

And specifically in the Mediterranean subregion (which includes all of Spain except Canary Islands):

- An increase in aridity and forest fires is expected.
- An increase in extreme temperatures is expected, a decrease in precipitation and decreased snow cover.

The latest scientific evidence [3][5][6][7][8] reinforces the idea that prevention plans have a real effect on reducing mortality associated with excess temperatures, which, together with the possibility of repeating excessively hot summers in our country, justifies in itself the continuity of the Plan National.

Regulatory framework and scope

Regulatory framework

Order PRE/1518/2004, of May 28, which creates the Interministerial Commission for the effective application of the National Plan for Preventive Actions on the Effects of Excess Temperatures on Health.

Plan activation period

In general, the National Plan is activated on **May 16 until September 30** every year.

In addition, a flexibility criterion is introduced that allows activation outside this period, through monitoring during the last fifteen days prior (May 1 to 15) and fifteen days after (October 1 to 15) the activation period of the National Plan.
aforementioned. Together with the established flexibility criterion, the National Plan will monitor maximum temperatures and health risk levels due to high temperatures in the event of unusual episodes of high temperatures outside the aforementioned dates.

Territorial disaggregation scope

The National Plan is disaggregated for the **50 provincial capitals and 2 Autonomous cities.**

On the other hand, in those Autonomous Communities that have their own Preventive Action Plans for excess temperatures, other areas of specific disaggregation may be available for their geographical territories.

Health impact of temperatures extreme

Health effects

Human exposure to elevated environmental temperatures can cause an insufficient physiological response of the thermoregulatory system. Excessive heat can alter our vital functions when the body is unable to compensate for variations in body temperature.

A very high temperature produces loss of water and electrolytes that are necessary for the normal functioning of the different organs.

In some people with certain chronic diseases, undergoing certain medical treatments and with disabilities that limit their autonomy, thermoregulation mechanisms may be decompensated.

Exposure to excessive temperatures can cause health problems such as cramps, dehydration, heat stroke, heat stroke (with multi-organ problems that can include symptoms such as unsteady gait, seizures and even coma). The heading identified as a direct cause of mortality due to excess environmental temperature in the International Classification of Diseases and Causes of Death, 10th revision, is **"X-30: Exposure to excessive natural heat."**

The impact of exposure to excessive heat is influenced by physiological aging and underlying diseases. Normally, a healthy individual tolerates a variation in their internal temperature of approximately 3°C, without their physical and mental conditions being significantly altered. From 37°C onwards, a physiological defense reaction occurs.

Older people and children are more sensitive to these temperature changes.
The former have a reduced sensation of heat and, therefore, the ability to protect themselves, there being a parallel between the decrease in the perception of thirst and the perception of heat, especially when they suffer from neurodegenerative diseases. Added to this is the reduced thermolysis of the elderly (numerous sweat glands are fibrous and the capillary vasodilation capacity is reduced). Lower thermolysis capacity also occurs in diabetes and neurodegenerative diseases.

Children who have chronic health problems or those who take certain medications may be, like adults, more susceptible to heat-related illnesses. Furthermore, specific physiological characteristics occur in childhood, mostly related to body water composition, sweat pattern and metabolic heat production, which put children at a thermoregulatory disadvantage compared to adults, especially when They exercise or are very physically active in hot or humid environments. On the other hand, minors - and even up to adolescence - cannot or do not take the necessary measures to prevent or replace fluid loss, and are exposed to direct sunlight to the point of exhaustion if they are not supervised by an adult. Children who are overweight or who wear too many clothes, especially if they do not sweat, are also more susceptible.

Impact on mortality

As calculated for the 2000-2009 time series by the Carlos III Health Institute [10], the risk of mortality attributable to high temperatures increases, with a probability of 95%, between 9.1% and 10.7% for each degree that the ambient temperature rises above the impact threshold on the health due to excessive temperatures in the provinces of Spain. The mortality associated with high temperatures in the referenced study was 13,119 deaths attributable to high temperatures, that is, about 1,300 deaths/year. In the period studied throughout Spain, 4,373 days of extreme heat were recorded (taking into account that extreme heat can occur on the same day in several provinces simultaneously and are computed differently); That is, every day that there is an episode of extreme heat, mortality increases, on average, by 3 deaths/day.

Excess mortality has been associated with periods of 3 or more consecutive days of unusual high temperatures, and its effects can be observed during such periods or with a delay of up to three days.

Risk factor's

The main risk factors associated with exposure to high temperatures are:

Personal factors

- People over 65 years of age.
- Infants and children under 4 years of age.
- Pregnant women.
- People with cardiovascular, respiratory and mental diseases (dementia, Parkinson's, Alzheimer's,...).

- People with chronic diseases (diabetes mellitus, morbid obesity,...).
- People with certain medical treatments (diuretics, neuroleptics, anticholinergics and tranquilizers).
- People with memory disorders, comprehension or orientation difficulties or little autonomy in daily life.
- People with difficulties adapting to heat.
- People with acute illnesses during temperature episodes excessive.
- People who consume alcohol and other drugs.

Environmental, labor or social factors

- People who live alone, on the street and/or in social and economic conditions unfavorable
- Homes with no air conditioning and/or difficult to cool.
- Excessive exposure to heat for work reasons (manual work outdoors or that require high contact with hot environments), sports (sports of great physical intensity) or leisure.
- Environmental pollution.
- Very urbanized environment.
- Continuous exposure for several days to high temperatures that they keep at night.

Local factors

Although the previous mechanisms act in a general way, local factors play a decisive role, since they determine the comfort temperature, the threshold temperatures to be considered and the temperature-mortality association, that is, the magnitude of the impact.

The main local factors are:

- Demography, which determines the composition of the population pyramid and, therefore therefore, the importance of susceptible groups.
- Climatology, to the extent that individuals adapt to the local climate. This explains that the effect of thermal extremes does not depend on absolute values, but rather on whether or not we are within the normal range of temperatures in a certain place.

Plan Objectives

The **objective** of this National Plan is to reduce the impact on the health of the population as a consequence of excess temperature.

The strategy is based on the following actions:

- ÿ Development of the Environmental Information System that includes the prediction of temperatures.
- ÿ Information to the population about the effects of excessive heat and measures protection and prevention.
- ÿ Development of the Mortality Information System.
- ÿ Information to health and social services professionals.
- ÿ Coordination with social services for the identification of groups of risk, especially both children and very elderly people.
- ÿ Coordination with the competent administrations and entities.

Coordination and management of the Plan

In order to guarantee the effective application of the National Plan, the Interministerial Commission will continue to carry out the functions assigned in **Order PRE/1518/2004,** of May 28, which creates the Interministerial Commission for the effective application of the National Plan. Preventive Actions for the Effects of Excess Temperatures on Health.

The Commission is chaired by the head of the General Directorate of Public Health of the Ministry of Health and is made up of a representative of the following institutions with the rank of Deputy Director General:

- ÿ Ministry of the Interior. General Directorate of Civil Protection and Emergencies.
- ÿ Ministry for the Ecological Transition and the Demographic Challenge. State Meteorological Agency (AEMET).
- ÿ Ministry of Social Rights and Agenda 2030. Institute for Seniors and Services Social (IMSERSO).
- ÿ Ministry of Territorial Policy. General Directorate General Administration of the State in the Territory.

The head of the General Subdirectorate of Environmental Health will act as secretary. Occupational Health of the Ministry of Health.

The functions of this Commission are the following:

1st. Prepare guidelines for compliance with the National Plan at the State level.
2nd. Establish preventive and control strategies that are considered appropriate in light of new evidence.
3rd. Activate information levels in coordination with the Communities Autonomous and taking into account the competency frameworks.
4th. Propose the organizational, structural and preventive measures necessary to avoid or reduce the impact of thermal extremes on health.
5th. Prepare risk assessment, management and communication plans.

The Interministerial Commission will request, when it considers it necessary, the advice of Scientific Societies and public and private entities that it considers most appropriate for the performance of its functions.

The Interministerial Commission is the body responsible for coordination with public and private entities and with the necessary powers for the execution of this National Plan.

In this sense, coordination mechanisms will be established to guarantee the application of the National Plan with the following entities:

- Ministries of Health and Social Services of the Autonomous Communities.
- Ministries of the Interior (General Directorate of Civil Protection and Emergencies), for the Ecological Transition and the Demographic Challenge (AEMET and General Directorate of Biodiversity and Environmental Quality) and of Justice (Civil Registry).
- Public and private media.

Methodological criteria applied

For the correct development of the National Plan, the AEMET provides the maximum temperatures expected for that day and the predictions for the following two days on a daily basis. These temperatures will be provided disaggregated by provincial capital.

The risk levels will be assessed from which to communicate with the affected Autonomous Community, to jointly implement the measures provided for at the corresponding level.

The information provided daily by AEMET to the Ministry of Health, from May 1 to October 15, is the following:

- Data on maximum and minimum temperatures observed the previous day, in all the provincial capitals.
- Matrix of objective predictions of maximum temperatures for all capitals province, between D+1 and D+3.

Reference thresholds for health impact due to high temperatures

The threshold temperatures for health impact due to high temperatures have been calculated by analyzing the association between time series of mortality and temperature at the provincial level. This procedure is based on methodology consolidated in the scientific literature [9], and is detailed below.

The variables used were:

- Daily mortality: count of the number of deaths from all causes except accidents (ICD10: A00-R-99), occurring at the provincial level. These data were provided by the National Statistics Institute (INE).
- Maximum daily temperature: maximum daily temperature in degrees Celsius recorded by a reference observatory for each province. The meteorological data, as well as the reference observatories selected in each case, were provided by the State Meteorological Agency (AEMET).

The time series used includes all daily cases between January 1, 2009 and December 31, 2019. Initially, the time series included observations related to the year 2020; but after an initial descriptive exploration, the data from this last year were discarded due to presenting notable mortality anomalies, possibly due to the emergence of the COVID-19 pandemic in Spain.

First, missing values were imputed using linear interpolation.

ARIMA models controlled for seasonalities were then fitted.
These seasonalities were generated with sine and cosine functions of periodicity.
annual, biannual, quarterly, four-monthly and monthly. These models generate a residual error – distance between the expected and observed mortality values – free of seasonality and trend. In this way, by associating the residual error with the maximum daily temperatures, spurious statistical associations resulting from the shared cyclical behavior between mortality and temperature are prevented.

Furthermore, the effects of heat waves on mortality occur over time, with a first peak in mortality in the first 3 days of the episode.
Therefore, the moving average of the residual errors over 3 days was calculated.

To determine which temperature correlates with the mortality anomalies, the 3-day residual error of the ARIMA models was added with the average for overlapping intervals of two degrees Celsius for the summer series (June-September).
Thus, for each interval the average of this variable and its confidence interval at 95% probability (95%CI) were calculated. Likewise, the total average residual error and its upper limit at 95% probability were calculated. In this way, the threshold temperatures coincide with the high temperature ranges, in which the residual error of the model is statistically higher than its total mean.

In those provincial capitals where maximum mortality trigger temperatures have not been obtained, the temperature corresponding to the 95th percentile of the time series studied during the summer (June 1 to September 30, 2009-2019) has been used as the threshold temperature.

Risk levels derived from maximum temperatures

Selection of limits for different levels of health risk due to high temperatures

Once the threshold temperatures of impact on health due to excess temperatures in each province were calculated, different alert scenarios were simulated based on the operation of the decision algorithm. It quantifies the high temperature index as the number of degrees by which the temperature threshold is exceeded, according to AEMET forecasts in the reference observatories established for each day and the two consecutive future days.

Thus, the indices for high temperatures were calculated in a random sample of provinces during the period 2009-2019. The provinces were recruited into the sample by generating an equiprobable random sequence of ones and zeros. As a result

The following 24 provinces were included: Alicante, Asturias, Ávila, Balearic Islands, Barcelona, Cádiz, Castellón, Córdoba, Girona, Granada, Huelva, Huesca, Madrid, Murcia, Ourense, Pontevedra, Salamanca, St. Cruz de Tenerife, Segovia, Teruel , Toledo, Valencia, Valladolid and Zaragoza.

For each of them, the high temperature indices, their 90th percentiles and the median of the 90th percentiles in the 24 provinces were calculated – 90th percentile of the heat wave index = 3-. From there, different alert scenarios were explored with the following transitions from yellow to orange (first limit) and orange to red (second limit):

Table 1. Scenarios explored for establishing health risk levels due to high temperatures

Scenarios	First limit	Second limit
E1	2	4
E2	2.5	4
E3	3.5	5
E4	3.5	7
E5	4	7

Finally, the values of the fourth traffic scenario were taken, as they are those that establish a more proportionate escalation in the progression of the alert level.

This represents a fixed transition in all provinces, with its own limitations that imply applying universal thresholds in provinces and areas that are essentially different in terms of the behavior of their climate and vulnerability status to high temperatures.

However, this transition between risk levels will be applied provisionally while waiting to establish the specific risk factors for each province, as well as the forecast day. At that time, a system based on the direct quantification of estimated risks will be established; which are now considered indirectly to the extent that higher index episodes are associated with higher intensity health impacts.

Health risk levels due to high temperatures

The criteria for assigning health risk levels for situations of excess temperature is based on a decision algorithm based on:

- The difference between the maximum predicted temperature and the threshold temperature (only when the maximum predicted temperature is greater than the established threshold temperature), with a persistence over time of 3 days.
- The resulting value will be multiplied by a "risk factor"1 that will vary depending on the province.
- Finally, the resulting value of the three days is added and the result obtained will decide the level of risk.

Equation 1. Alert level decision algorithm

((to í 1 ÿ) ÿ) ÿ í 2) + ((á í 3)) í 1) + ((á í 2 ÿ í 3 ÿ) ÿ

The assignment of health risk levels *(Table* 2) is carried out using the following criteria based on the value obtained in the decision algorithm:

- If the result obtained in the decision algorithm is 0, the index is "0", the assigned level is called **"Level** 0" or absence of risk, and is represented with the **color green.**
- If the result obtained in the decision algorithm is greater than 0 and less than or equal to 3.5, the index is "1", the assigned level is called **"Level** 1" or low risk, and is represented with the **color yellow .**
- If the result obtained in the decision algorithm is greater than 3.5 and less than or equal to 7, the index is "2", the assigned level is called **"Level** 2" or medium risk, and is represented with the **color orange. .**
- If the result obtained in the decision algorithm is greater than 7, the index is "3", the assigned level is called **"Level** 3" or high risk, and is represented with the **color red.**

[1] For this year the risk factor will be 1 for every day and all provinces. This factor will be modified in future years adapting it to the circumstances of each territory.

Table 2. Definition of health risk levels due to high temperatures

Risk level	Denomination	Index
0	No risk	0
1	Low risk	1
2	Medium risk	2
3	High risk	3

Information and surveillance systems

Current health surveillance systems have adequate information systems to know in advance the risk of temperature increases with acceptable reliability, as well as the impact that these temperatures have on the health of the population measured in terms of mortality.

System objectives

- Know in advance the health risk of high temperatures that may affect a specific population in a geographical area.
  concrete.
- Know the real impact of high temperatures on the health of the population. • Identify the need to reinforce the available healthcare resources.

Characteristics

In the institutional framework, it is a cooperative system of different areas of the health and non-health Administration (AEMET, Ministry of Health, IMSERSO, Ministry of Justice, CCAA, ISCIII, etc.)

Different levels of information are established, depending on the risk, according to the background and characteristics of each territory, the available time series and the available temperature predictions.

Environmental information system

Preventing the health effects of high temperatures is possible to a large extent. The AEMET is currently capable of predicting maximum temperatures with high reliability and several days in advance.

Meteorological variables

The meteorological variables that are taken into account are: the maximum temperatures predicted for 3 days, the maximum temperatures recorded the day before the prediction date and the reference thresholds of health impact due to high temperatures.

This information is provided daily by the AEMET, disaggregated by province and sent electronically. This information, also daily and electronically, along with the map of health risk levels due to high temperatures, is distributed to the health authorities of the Autonomous Communities, as well as the rest of the institutions involved in the National Plan.

Daily mortality monitoring (MoMo)

Within the framework of this National Plan, the monitoring of daily mortality is complementary to meteorological information. On the one hand, it allows us to evaluate health risk situations, assess the impact of excess temperature on mortality and identify excess general mortality from all causes.

The goal of mortality monitoring is to improve prevention and response capacity. MoMo and Kairós Index are daily mortality surveillance systems associated with temperature excesses, developed in the Daily Mortality Surveillance Unit (MoMo) of the National Epidemiology Center (CNE) of the Carlos III Health Institute, with which contributes to the Plan. The Kairos Index, implemented in the summer of 2021, provides mortality alerts associated with excess temperatures and since April 2022 MoMo has been using a new model that, in addition to excess mortality from all causes, estimates the impact of excess temperatures on the mortality of the population, giving estimates of excess mortality attributable to temperature. The CNE of the Carlos III Health Institute will inform the Ministry of Health on a daily basis of the alert signals detected, according to the criteria defined in the models2,3 .

The daily information and reports generated by this model during the activation period of the National Plan are available to the members of the Commission Interministerial.

Methodology

MoMo and the Kairos Index use three data sources:

- Daily deaths for the last ten years, not including those in 2020.
  This series is obtained from both the consolidated data of the National Institute of Statistics (INE), such as the most recent deaths provided by the Ministry of Justice on deaths from all causes reported in civil registries of the computerized municipalities (which corresponds to approximately 93% of the population).

- Temperatures, according to the AEMET at the provincial level, in the same period of time, and including the current year.
- The population by age group and province, extracted from the INE.

[2] https://momo.isciii.es/panel_momo/
[3] http://momo.isciii.es/kairos/

The analysis is carried out both for the overall population and by age groups. The age groups used are: 0-14, 15-44, 45-65, 65-74, 75-84, plus 85 years.

As a warning system, the Kairós Index establishes warnings for each day that define different levels of mortality risk. There are three levels of the Kairós Index: Level 1, 2 and 3 that define small or no, moderate and high mortality risks, respectively. Always for the current day and the following four days, as well as by population level (national, Autonomous Communities (CCAA) and provincial) and by age group (all ages, 0-14, 15-44, 45-65 , 65-74, 75-84, over 85 years).

As a system for estimating the impact of heat on population mortality, MoMo offers daily estimates of the number of deaths from all causes associated with excess temperature for the current day for each population area and age group mentioned. The Kairós index will be published daily, at the national, CCAA and provincial level, which indicates the probability of excess mortality attributable to excess temperature occurring, on the website of the Carlos III Health Institute4

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The Kairós and MoMo Index uses a GAM *(generalized additive model)* Poisson model, which is adjusted by province, level for which daily temperature information is available, and by age groups: 0-14, 15-44, 45 -65, 65-74, 75-84, plus 85. The models include a term for trend, seasonality and for the ATO *(accumulated thermal overcharge) variables,* defined as the number of degrees that the maximum temperature is above the mortality trigger threshold (the thresholds used are those that appear in Annex I), multiplied by the number of days and FATO defined as the number of degrees that the minimum temperature is below the mortality trigger threshold, multiplied by the number of days5 .

Mortality notices

The model detects situations of excess mortality (warnings) due to excess temperature. To do this, it measures the probability that an increase in the number of deaths attributable to excess temperature of 10% or more will occur (or has occurred).

The Kairos Index is constructed according to the probability of excess obtained:

- **Kairós** 1: if the probability of excess is less than 40%. Indicates the absence of mortality warnings attributable to excess temperature.

[4] http://momo.isciii.es/kairos/
[5] https://momo.isciii.es/panel_momo/#section-documentación

- **Kairós** 2: if the probability of excess is between 40% and 60%. Indicates a mortality warning attributable to excess mid-level temperature.
- **Kairós** 3: if the probability of excess is above 60%. Indicates a warning of mortality attributable to excess high-level temperature.

Performances

All the daily reports from MoMo and the Kairós Index, which include alerts on excess mortality at the national level, along with the Kairós index by CCAA, will be made public daily on the website of the Carlos III Health Institute.

Deaths attributable to excessive temperatures

In addition, information on mortality attributable to heat, in this way when a death occurs associated with exposure to excessive natural heat (heat stroke), the health authorities of the CCAA must complete the information collected in Annex II and send it to the General Subdirectorate of Health Environmental and Occupational Health of the Ministry of Health.

The objective pursued is to improve the monitoring of mortality attributable to heat during the activation period of the National Plan.

Care program for the most vulnerable people

Through the network of municipal social services, responsible for the management of services such as home help, tele-care and social centers, work will be done on identifying the target population, since the first two services are aimed at vulnerable groups.

The distribution of information for protection and prevention through this network will seek to reach the most susceptible population. With this objective, collaboration agreements can be established with the Spanish Federation of Municipalities and Provinces to reach the town councils.

The activation of the rest of the specialized resources (day centers, residences, homes, occupational centers, etc.) will be coordinated through the Autonomous Communities and Cities.

The identification and care of the most vulnerable people will be carried out through the services available in the health and social care networks.

Preventive actions associated by risk level

The associated preventive actions are described below by level of health risk due to high temperatures.

Preventive actions associated with Levels 0 and 1 of health risk due to high temperatures

The actions described below refer to those that are carried out in a systematic way for the activation and implementation of the National Plan and that are maintained in the time periods in which risk levels are 0 and 1.

- Inform the health authorities of the Autonomous Communities of the implementation of the National Plan in its annual campaign on May 16, as well as the request for information regarding emergencies, admissions and deaths attributed to heat stroke or the effects of excessive temperatures. .
- Implementation of the action programs by the agreements of social services.
- Information to the population of the existence of the National Plan and its compatibility with those of the Autonomous Communities that already have it.
- Information to the population about general protection and prevention measures individuals and in the immediate environment.
- Information to the population about the most vulnerable people and groups.
- Information to the population about the meaning of risk levels.
- Daily electronic distribution by the Department, to the members of the Interministerial Commission, to the ministerial departments integrated into it, to each of the representatives communicated by the Autonomous Communities and to the authorities of the Ministry of Health of the maps by provinces of levels of excessive temperatures and the information on which they are based.
- Daily addition to the Department's website of information on excessive temperature levels, disaggregated by Autonomous Communities, activating hyperlinks with their own information systems, for those Autonomous Communities that so provide.

- Updating and maintaining directories of authorities of the Public Administrations involved in the Plan.
- Coordination with the health authorities of the Autonomous Communities that They develop and apply their own Plan.

- Coordination with the Autonomous Communities of the application of the information campaign for professionals and public awareness.
- Monitoring of information related to activities related to social policy.
- Implementation of the Mortality Health Information and Surveillance System attributable to heat.
- Preparation of periodic statistical summaries of meteorological and socio-health information generated by the different Information Systems.

Preventive actions associated with Level 2 health risk due to discharges temperatures

In addition to maintaining the measures planned for the two previous levels, the following are contemplated:

- Immediate communication to the members of the Interministerial Commission of the presentation of the level through telematic means (SMS).
- Immediate communication to those responsible in the affected Autonomous Communities via electronic means (SMS).
- Intensification of coordination with the Autonomous Communities for the information to health and social services professionals.
- Intensification of information about the meaning of the level, and issuance of advice and health recommendations according to the level.
- Intensification of information to the population about the most vulnerable people and groups vulnerable to exposure to excessive heat.
- Assessment of the adoption of additional measures of a general nature or aimed at specific groups.

Preventive actions associated with Level 3 health risk due to discharges temperatures

- Reinforcement of the measures applied at Level 2.
- Intensification of information on the meaning of the level, and issuance of health advice and recommendations to the population at risk.
- Immediate communication to the members of the Interministerial Commission and those responsible for the Autonomous Communities of the presentation of the level, for the assessment of the actions that may be necessary in each case to manage the risk.

- Assessment by the Health Alerts and Emergencies Coordination Center of the state of the situation.

Risk communication

Communication and information to the population, higher risk groups, health professionals and social services

During the activation period of the National Plan, all information related to it will be available on the website of the Ministry of Health (level of health risk, general recommendations, preventive actions, etc.). Also, citizens will be informed through social networks such as Facebook and Twitter.

A “Temperature and Risk Level Subscription Service” will be made available to those citizens who wish to do so, through which they will be able to receive an email and/or SMS with daily information on temperatures and the level of risk for the health of those provinces that are of interest to them.

Information will be provided to the media to provide useful advice and practical measures to prevent the health effects of exposure to high temperatures. These awareness activities will aim to increase individual prevention capacity and confront high temperatures by applying easy and accessible measures. An essential objective is the forecasting and anticipation of risks. To achieve this, the aim is to promote solidarity and the prevention capacity of the family, neighborhood and community environment, especially to care for the sick and socio-economically most needy people.

Measures already established at national level in the area of social services will be strengthened so that people at risk, their families, neighbors, etc. They can communicate emergency situations or receive information and mobilize help if necessary.

Plan Monitoring

Weekly summaries

During the activation period of the National Plan, daily and weekly monitoring is carried out detailing the health risk levels issued up to the moment of the end-of-season report.

Plan Evaluation

Once the summer season is over, a final report will be prepared with the balance of the current season.

This report will include information on:

- Climatological situation in Spain during the summer months
- Activation of risk levels
- Daily Mortality Monitoring (MoMo)
- Specific mortality
    - o CIE10 – X30 (Exposure to excessive natural heat)
    - o Number of deaths notified to the Ministry of Health during the activation period of the National Plan by the health authorities of the Autonomous Communities
- Information to the population

This report is published on the website of the Ministry of Health, where you can consult the reports since 2004.

Indicators

The following are established as monitoring indicators of the National Plan:

- Number of alerts for high temperatures issued during the period of Plan activation
- Percentage of days on alert for high temperatures throughout the campaign
- Total number of days on alert for high temperatures/Total number of campaign days
- Number of emails sent to citizens through the subscription service
- Number of SMS sent to citizens through the subscription service
- Mortality from selected causes during the Plan activation period
    National
    - o CIE10-X30 (Exposure to excessive natural heat)

- Number of deaths notified to the Ministry of Health during the activation period of the National Plan by the health authorities of the Autonomous Communities

- Estimation of deaths attributable to excess temperatures (MoMo)

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Annexes

Annex I. Provincial reference thresholds for health impact due to discharges temperatures

Illustration 1. Reference thresholds for health impact due to high temperatures (°C), by province

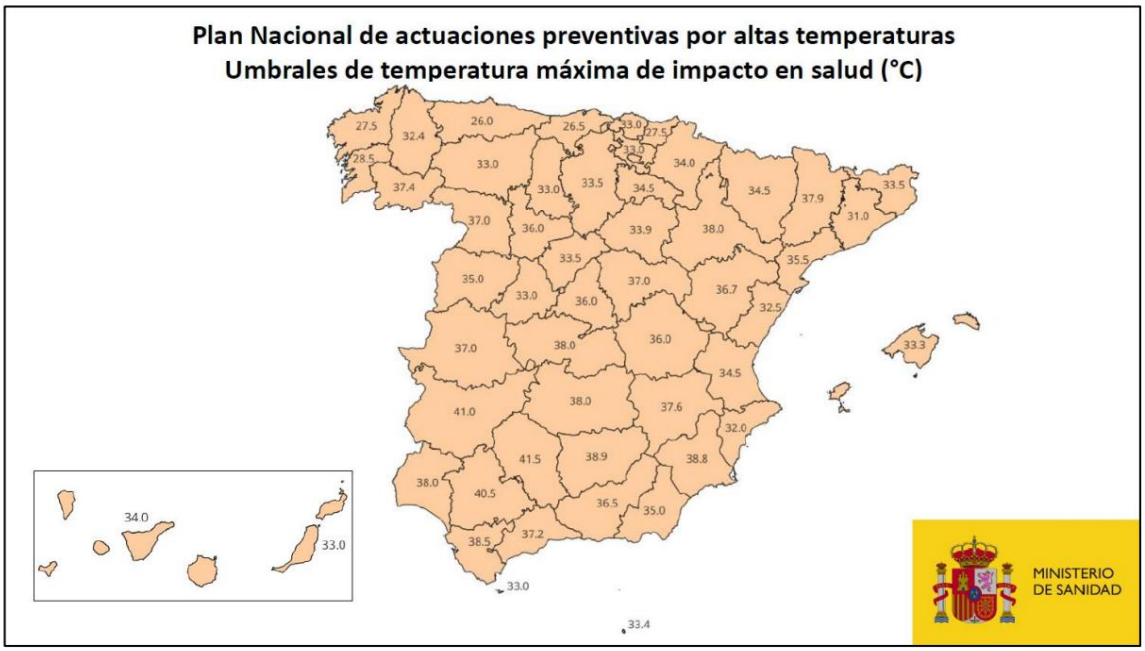

Table 3. Reference thresholds for health impact due to high temperatures (°C), by province

PROVINCE	THRESHOLD TMAX (°C)	PERCENTILE	AEMET REFERENCE OBSERVATORY
ANDALUSIA			
Almeria	35	91.3	6325O-ALMERÍA/AIRPORT
Cadiz	38.5	91.9	5973-CÁDIZ,OBS.
Cordova	41.5*	95	5402-CÓRDOBA/AIRPORT
Grenade	36.5	83.3	5514Z-GRANADA/AIR BASE
Huelva	38*	95	4642E-HUELVA, EAST RONDA
Jaen	38.9	96.5	5270B-JAEN
Malaga	37.2*	95	6155A-MALAGA/AIRPORT
Seville	40.5*	95	5783-SEVILLE/SAN PABLO
ARAGON			
Huesca	34.5	83.8	9898-HUESCA, AIRPORT
Teruel	36.7*	95	8368U-TERUEL
Saragossa	38	94.1	9434-ZARAGOZA, AIRPORT
ASTURIAS, PRINCIPALITY OF			
Asturias	26	83.4	1249X-OVIEDO
BALEARS, ILLES			
Balearic Islands	33.3*	95	B228-PALMA-PORT
CANARY ISLANDS			
Palms, The	33	97.5	C658X-LAS PALMAS GC-TAFIRA/ZURBARÁN
Santa Cruz de Tenerife	3. 4	97.6	C449C-STA.CRUZ DE TENERIFE
CANTABRIA			
Cantabria	26.5	83.9	1109X-SANTANDER AIRPORT
CASTILLA AND LEÓN			
Avila	33	92.3	2444-ÁVILA
Burgos	33.5	94.1	2331-BURGOS/VILLAFRIA
Lion	33	95.8	2661-LION/VIRGIN OF THE ROAD
Palencia	33	82	2401X-PALENCIA FARM VIÑALTA
Salamanca	35	91.2	2867-SALAMANCA/MATACAN
Segovia	33.4	88.7	2465-SEGOVIA
Soria	33.9*	95	2030-SORIA
Valladolid	36	94.6	2422-VALLADOLID
Zamora	37	95.9	2614-ZAMORA
CASTILLA LA MANCHA			
Albacete	37.6*	95	8175-ALBACETE/LOS LLANOS
Real city	38	91	4121-CITY REAL
Basin	36	93.8	8096-BASIN
Guadalajara	37	94.7	3168D-GUADALAJARA
Toledo	38	87.9	3260B-TOLEDO
CATALONIA			

PROVINCE	THRESHOLD TMAX (°C)	PERCENTILE	AEMET REFERENCE OBSERVATORY
Barcelona	31	93	0076-BARCELONA/AIRPORT
Girona	33.5	84	0367-GIRONA/COSTA BRAVA
Lleida	37.9*	95	9771C-LLEIDA
Tarragona	35.5	89	0016A-REUS/AIRPORT
VALENCIAN COMMUNITY			
Alicante/Alacant	32	84.9	8025-ALICANTE
Castellón/Castelló	32.5	91.2	8500A-CASTELLÓN-ALMASSORA
Valencia/Valencia	34.5	95	8414A-VALENCIA/AIRPORT
ESTREMADURA			
Badajoz	41	98.1	4452-BADAJOZ/TALAVERA LA REAL
Caceres	37	86.4	3469A-CÁCERES
GALICIA			
Coruña, A	27.5	89.1	1387E-A CORUÑA AIRPORT
lugo	32.4*	95	1505-LUGO/ROZAS
Ourense	37.4*	95	1690A-OURENSE
Pontevedra	28.5	81.9	1484C-PONTEVEDRA
MADRID, COMMUNITY OF			
Madrid	36	88.5	3195-MADRID,RETIRO
MURCIA, REGION OF			
Murcia	38.8*	95	7178I-MURCIA
NAVARRA, FORAL COMMUNITY OF			
Navarre	3. 4	84.3	9263D-PAMPLONA, AIRPORT
BASQUE COUNTRY			
Araba/Álava	33	90.4	9091R-VITORIA/FORONDA
Bizkaia	33	94.4	1082-BILBAO/AIRPORT
Gipuzkoa	27.5	85.1	1014A-SAN SEBASTIAN/FUENTERRABIA
RIOJA, LA			
Rioja, La	34.5	86	9170-LOGROÑO, AIRPORT
CEUTA	33	93.3	5000C-CEUTA
MELILLA	33.4*	95	6000A-MELILLA

* Temperatures that correspond to the 95th percentile of the series of maximum temperatures analyzed (summer, 2009-2019)

Annex II. Information regarding deaths attributable to discharges temperatures

With the aim of improving the monitoring of mortality attributable to heat during the activation period of the National Plan for Preventive Actions against the Effects of Excess Temperatures on Health, the necessary information on each death attributable to heat that occurs is detailed below. occurs in the national territory and is the subject of communication by the Autonomous Communities and Autonomous Cities to the General Subdirectorate of Environmental Health and Occupational Health of the Ministry of Health via email **(sgsasl2@sanidad.gob.es).**

This information comprises three blocks of information:

1.- Individual and Exposure Data: to report on basic individual variables and exposure to excessive temperatures. In this case, the environmental and social risk factors that the National Plan includes are considered.

2.- Clinical-care data: to report on the circumstances of admission, the risk factors of a clinical nature that are included in the National Plan and the individual condition upon admission measured by three conditions associated with heat pathology, namely: hyperthermia , dehydration and hyponatremia.

3.- Data related to the death and the communication of information

The data corresponding to each of the blocks is detailed below:

Individual and exposure data

- ÿ Age:
- ÿ Sex:
- ÿ Profession:
- ÿ Location of residence:

Exposure6 present risk factor:

ÿYes ÿNo

If yes, indicate which one or which:

- ÿ People who live alone

[6] **Exposure:** Presence of an environmental or social risk factor (for example, people living alone, on the streets and/or in unfavorable conditions, lack of air conditioning and homes that are difficult to cool), excessive exposure to heat for work reasons (manual work in outdoors or that require high contact with hot environments), sports (sports of great physical intensity) or leisure.

ÿ People who live on the streets and/or in unfavorable conditions

ÿ People living in collective residences

ÿ Lack of air conditioning

ÿ Housing that is difficult to cool

ÿ Exposure for occupational reasons (manual work outdoors and/or requiring high contact with hot environments)

ÿ Sports reasons (high physical intensity sports)

ÿ Leisure reasons

ÿ Others: ……

Clinical-care data

1. Presence of individual risk factors[7] .

   ÿYes ÿNo

   If yes, indicate which one or which

   ……..

2. Location of hospital admission:

3. Hospital admission date:

4. Hospital admission service (emergency, cardiology, geriatrics,...):

   ……..

5. Presence upon entry of:

   to. **Hyperthermia** ÿYES ÿNO

   b. **Dehydration** ÿYES ÿNO

   c. **Hyponatremia** ÿYES ÿNO

[7] **Individual risk factors:** such as cardiovascular, respiratory and mental diseases (dementia, Parkinson's, Alzheimer's,...); chronic diseases (diabetes mellitus, morbid obesity,...); medical treatments (diuretics, neuroleptics, anticholinergics and tranquilizers); memory disorders, comprehension or orientation difficulties or little autonomy in daily life; acute illness during episode of excessive temperature; consumption of alcohol and other drugs.

Death and communication data

1. Location of death:
2. Date of death:
3. Date of receipt of death information in the Health Service Autonomous Community or Autonomous City in charge of its transmission to the General Subdirectorate of Environmental Health and Occupational Health of the Ministry of Health:
4. Date of sending the information to the General Subdirectorate of Health Environmental and Occupational Health of the Ministry of Health:

Annex III. General recommendations to prevent the effects of high temperatures on health

General recommendations to prevent the effects of high temperatures about health

1. Drink water and fluids frequently, even if you do not feel thirsty and independently of the physical activity you do.
2. Avoid drinks with caffeine, alcohol or very sugary, as they can promote dehydration.
3. Although anyone can suffer a problem related to heat, pay special attention to: babies and minors, infants and pregnant women, as well as older people or people with diseases that can be aggravated by heat (such as heart disease, kidney disease, diabetes , hypertension, obesity, cancer, pathologies that hinder mobility, dementia and other mental illnesses, as well as drug or alcohol abuse).
4. Stay as long as possible in cool, shaded or heated places, and refresh yourself whenever you need to.
5. Try to reduce physical activity and avoid doing outdoor sports in the central hours of the day.
6. Wear light, loose-fitting, breathable clothing.
7. Never leave anyone in a parked and closed vehicle (especially minors, elderly people or people with chronic illnesses).
8. Consult your health professional if symptoms last more than an hour and may be related to high temperatures.
9. Keep your medicines in a cool place; heat can alter its composition and its effects.
10. Eat light meals that help replace salts lost through sweat (salads, fruits, vegetables, juices, etc.).

Credits

Interministerial Commission

presides	**General Director of Public Health.** Ministry of Health
Vocal	**General Deputy Director of Civil Protection and Emergencies.** Ministry of Interior
Vocal	**Deputy Director of the State Meteorological Agency.** Ministry for the Ecological Transition and the Demographic Challenge
Vocal	**Deputy Director of the Institute for the Elderly and Social Services (IMSERSO).** Ministry of Social Rights and Agenda 2030
Vocal	**Deputy Director General of Institutional Relations of the General Administration of the State in the Territory.** Ministry of Territorial Policy
Secretary	**General Deputy Director of Environmental Health and Occupational Health.** Ministry of Health

Interministerial Working Group

presides	**Deputy Director General of Environmental Health and Occupational Health.**
	DG Civil Protection and Emergencies
	Institute of Seniors and Social Services (IMSERSO)
	Ministry of Territorial Policy
	Carlos III Health Institute. ENS
	Carlos III Health Institute. CNE
	State Meteorological Agency (AEMET)
	Coordination Center for Health Alerts and Emergencies (CCAES)
	SG Environmental Health and Occupational Health

Madrid, 2023