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METADATA – EXTREME TEMPERATURES

Description	Extreme temperatures are defined as short-term daily mean temperatures that deviate from the optimal temperature associated with minimal risk of adverse health outcomes, referred to as the minimum mortality temperature (MMT). Temperatures below the MMT are associated with cold-related health effects, while temperatures above the MMT are associated with heat-related effects. As the MMT depends on the local climate, it is estimated at the level of the municipality. The indicator used is the daily mean temperature, expressed in degrees Celsius, derived from gridded observational data covering Belgium.
Rationale	Extreme temperatures are associated with a range of cardiovascular, respiratory and other health outcomes. Evidence from meta-analyses and large cohort studies supports associations between both heat and cold with mortality and morbidity from ischaemic heart disease (IHD), stroke and COPD [1, 2, 3, 4], as well as heat-related diabetes [5], mental health outcomes [6], and kidney disease [7]. As the frequency and intensity of heat extremes are expected to increase with climate change, quantifying the health burden of extreme temperatures is of growing public health relevance. Both heat- and cold-attributable burden are estimated in this assessment.
Primary Data source	Exposure assessment is based on gridded observational temperature data provided by the Royal Meteorological Institute of Belgium (RMI) [8]. This dataset covers Belgium at a spatial resolution of 5 by 5 km, available since 1961 and continuously updated. It contains daily mean temperature values by municipality, derived from the interpolation of meteorological station observations using ancillary variables such as terrain elevation and proximity to water surfaces. Health outcome data are taken from cause-of-death (COD) microdata, pre-processed with a redistribution of ill-defined deaths and a mapping to the GBD classification [9]. The list of included outcomes is based on those supported by a literature review on heat-related hospital admissions in Flanders [10].
Indicator source	For each municipality, the daily mean temperature is extracted from the RMI grid pixel overlapping with the municipal centroid. Exposure-response functions (ERFs) are derived internally using a case time series design combined with a distributed lag non-linear model (DLNM) [11], linking daily cause-specific deaths to daily temperature values at the municipal level across Belgium. A moving window of 10 years is used for model fitting, allowing the ERF to vary over time to account for population adaptation and climatic changes. The population in each municipality is assumed to be uniformly exposed to the local ambient temperature.
Periodicity	RMI gridded observational data are available since 1961 and receive continuous updates. ERFs are re-estimated annually using a 10-year moving window. COD microdata are updated annually by Statbel.
Calculation, technical definitions and limitations	The health burden attributable to extreme temperatures is quantified using a short-term exposure approach. A Population Attributable Fraction (PAF) is calculated for each day of the year based on the relative risk (RR) corresponding to the daily mean temperature. Burden is attributed to heat when the daily mean temperature exceeds the MMT, and to cold when it falls below. Annual heat- and cold-attributable burdens are aggregated separately. The ERF derivation follows four steps: (1) generation of a temperature cross-basis using natural cubic splines over a 14-day lag period; (2) fitting of a generalized non-linear model (GNM) of the quasi-Poisson family, with confounders including long-term time trends, day of week, region, and daily mean relative humidity, PM10 and O3; (3) derivation of a cause-specific MMT; (4) prediction of daily RRs by municipality, sex and age group using a backward perspective [12].

	As the MMT is estimated cause-specifically, a weighted across-cause mean MMT is derived and applied uniformly for the final burden estimation. Outcomes included are Alzheimer's disease and other dementias, Asthma, Cerebrovascular disease, Chronic kidney diseases, Chronic obstructive pulmonary disease, Diabetes mellitus, Ischemic heart disease, Lower respiratory infections, Parkinson's disease and Trachea, bronchus, and lung cancers. Important limitations include: (1) health-related confounders such as respiratory pathogen circulation are not included in the model; (2) attributing burden across the full temperature range (rather than only extreme percentiles) may result in some overestimation, as moderate deviations from the MMT may fall within the range of population adaptation [13]; (3) the spatial resolution of 5 by 5 km is coarser than air pollution grids, though this is less critical in a time series design where temporal resolution is paramount.
International comparability	To ensure comparability of temperature-related burden estimates from Belgium to the other EU-14 countries, the values used in the international comparison are based on a dataset provided by the Global Burden of Disease study [14]. These values are publicly available.

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