COMUNE DI CANEGRATE PROVINCIA DI MILANO CODICE 10934	NUMERO 75	DATA 27-11-2023

OGGETTO:
ORDINE DEL GIORNO AVENTE AD OGETTO: "CONVERSIONE ECOLOGICA E CONTRASTO AI CAMBIAMENTI CLIMATICI"

COPIA

DELIBERAZIONE DEL CONSIGLIO COMUNALE

SESSIONE STRAORDINARIA, SEDUTA PUBBLICA

L'ANNO **DUEMILAVENTITRE** ADDÌ **VENTISETTE** DEL MESE DI **NOVEMBRE** ALLE ORE **20:30** NELLA SALA DELLE ADUNANZE, PREVIA L'OSSERVANZA DI TUTTE LE FORMALITA' PRESCRITTE DALLA VIGENTE NORMATIVA, VENNERO OGGI CONVOCATI A SEDUTA I COMPONENTI IL CONSIGLIO COMUNALE.

ALL'APPELLO RISULTANO:

COMPONENTE	P.	A.G.	A.I.	COMPONENTE	P.	A.G.	A.I.
MODICA MATTEO	X			MERAVIGLIA FRANCA	X		
SPIRITO DAVIDE	X			VENTURA ISOTTA ANNA	X		
LURAGO SARA	X			SAPONE STEFANO	X		
ZAMBON EDOARDO	X			MATTEUCCI MATTEO	X		
GAREGNANI ANNA	X			BUTTIGLIERI MARIA ANGELA	X		
SORMANI ILARIA	X			CAPRIGLIONE FRANCESCO	X		
PANSARDI TOMMASO	X			FORNARA CHRISTIAN	X		
FRATTO MARCO		X		INGRASSIA GIOVANNI	X		
BURATTI STEFANO	X						

TOTALE PRESENTI 16 TOTALE ASSENTI 1

ASSISTE IL SEGRETARIO GENERALE DOTT.SSA TERESA LA SCALA IL QUALE PROVVEDE ALLA REDAZIONE DEL PRESENTE VERBALE.

ESSENDO LEGALE IL NUMERO DEGLI INTERVENUTI, IL SINDACO MATTEO MODICA ASSUME LA PRESIDENZA E DICHIARA APERTA LA SEDUTA, PER LA TRATTAZIONE DELL'OGGETTO SOPRA INDICATO.

SEDUTA DEL CONSIGLIO COMUNALE IN DATA **27/11/2023** – ore **20.30**

DELIBERAZIONE N. **75**

OGGETTO : **ORDINE DEL GIORNO AVENTE AD OGGETTO: "CONVERSIONE ECOLOGICA E CONTRASTO AI CAMBIAMENTI CLIMATICI"**

Componenti presenti in aula n. 16 su n.17.

E' assente giustificato il Consigliere Marco Fratto.
E' inoltre presente l'Assessore Esterno: Maurizio M. Tomio.

Il Sindaco cede la parola al Consigliere Stefano Sapone per l'illustrazione dell'ordine del giorno in oggetto, allegata SUB B) al presente verbale.

Seguono gli interventi di alcuni Consiglieri Comunali, come riportato su supporto audio e depositato agli atti, a norma dell'art.60, 3° comma del vigente regolamento per il funzionamento del Consiglio Comunale e delle Commissioni Consiliari.

Alle ore 21.55 il Sindaco si assenta e rientra alle ore 22.10.

La seduta viene sospesa alle ore 22.25 per riprendere alle ore 22.35, per una breve riunione al fine di concordare un testo unitario.

Dopo la sospensione, viene portato all'approvazione un testo modificato dell'ordine del giorno.

IL CONSIGLIO COMUNALE

Visto l'ordine del giorno presentato dai Consiglieri del gruppo "Canegrate Insieme" Davide Spirito e Stefano Sapone prot. n. 16619 del 20/11/2023, allegata SUB B) al presente verbale;

Visto il testo emendato dell'ordine del giorno allegato SUB A) al presente verbale, concordato dai Capigruppo a seguito della sospensione della seduta di cui sopra;

Ritenuto di provvedere all'approvazione dello stesso;

Dato atto che la presente deliberazione costituisce mero atto di indirizzo e non necessita quindi del parere di cui all'art. 49, comma 1, del D.Lgs 267/2000;

Con voti favorevoli n.16, espressi per alzata di mano dai n.16 Consiglieri presenti e votanti;

D E L I B E R A

1) Di approvare l'ordine del giorno presentato dai Consiglieri del gruppo "Canegrate Insieme", Davide Spirito e Stefano Sapone, avente ad oggetto : "Conversione

ecologica e contrasto ai cambiamenti climatici" nel testo che si allega al presente atto SUB A) quale parte integrante e sostanziale, con le modifiche apportate dal Consiglio Comunale di cui in premessa.

All.ti/ - SUB A) ordine del giorno emendato ed approvato
SUB B) ordine del giorno prot. 16619 del 20/11/2023.

COMUNE DI CANEGRATE (MILANO)

Allegato alla deliberazione SUB A)
C.C. n. 75 del 27/11/2023

CANEGRATE INSIEME
MATTEO MODICA SINDACO

ORDINE DEL GIORNO
"Conversione ecologica e contrasto ai cambiamenti climatici"

Premesso che

- l'Italia è frequentemente attraversata da eventi climatici estremi caratterizzati da elevate temperature, incendi, nubifragi, grandinate anomale e violente trombe d'aria che hanno colpito diversi territori da nord a sud, in un crescendo di frequenza e di intensità, causando vittime e feriti, oltre che ingenti danni economici e ambientali;
- anche in Canegrate, lo scorso 24 luglio, si è verificato un evento meteorico eccezionale ed imprevedibile, con violenti scrosci di pioggia, tromba d'aria e grandine di rilevanti dimensioni, che hanno provocato ingenti danni sull'intero territorio comunale e sugli edifici di proprietà pubblica e privata;
- i cambiamenti climatici rappresentano una minaccia concreta e urgente ed è dovere delle istituzioni non sottovalutarne gli effetti perché interessano in modo diretto la vita dei cittadini;
- solo con azioni concrete e impegni seri possiamo sperare di avere cura e di proteggere il nostro pianeta, per preservare il benessere delle cittadine e dei cittadini oggi e per preservare da danni ancora maggiori quello delle generazioni future.
- la transizione energetica, fondamentale per mitigare e rallentare l'evolvere della crisi climatica, è anche una priorità assoluta per lo sviluppo sostenibile del territorio.

Considerato che:

- la Commissione Europea ha lanciato il Green deal, un piano per fare dell'Europa il primo continente a zero impatto ambientale entro il 2050, che rappresenta la migliore risposta alla sfida del cambiamento climatico;
- l'Osservatorio Città Clima di Legambiente ha rilevato che nei primi cinque mesi del 2023 si è registrato il +135% degli eventi climatici estremi rispetto allo stesso periodo del 2022[1];
- la rivista scientifica Nature ha pubblicato uno studio sull'associazione tra alte temperature e mortalità dove rileva che i più alti rischi di mortalità correlata al calore siano nei paesi vicino al Mar Mediterraneo e valgano per tutti i sessi e gruppi di età, con valori generalmente più elevati per gli anziani[2];
- nonostante ciò, il Governo ha deciso di eliminare dal PNRR nove progetti fondamentali per la transizione ecologica per un totale di 15,9 miliardi, molti dei quali coinvolgevano direttamente i comuni.

Rilevato che:

- la Direttiva RED II (RED è l'acronimo di *Renewable Energy Directive Recast* ovvero *Nuova versione aggiornata della direttiva sulle energie rinnovabili*) UE 2018/2001 in merito alle energie rinnovabili ha definito l'autoconsumo collettivo e le CER come un'aggregazione di autorità locali, cittadini,

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[1] https://cittaclima.it/2023/06/05/i-nuovi-dati-citta-clima-in-occasione-della-giornata-mondiale-dellambiente/
[2] https://www.nature.com/articles/s41591-023-02419-z; https://www.nature.com/articles/s41591-023-02649-1

piccole e medie imprese che si uniscono per produrre e condividere l'energia elettrica generata da fonti rinnovabili, portando vantaggi economici, ambientali e sociali ai singoli e alle comunità;

- le CER (Comunità Energetiche Rinnovabili) rivestono un ruolo strategico per diffondere tra la popolazione la cultura della sostenibilità, per sviluppare le rinnovabili e, se supportate da fondi pubblici mirati, per ridurre le disuguaglianze e sostenere persone che attraversano periodi di fragilità economica e/o povertà energetica; esse rappresentano una importante opportunità e un modello innovativo tanto sociale, quanto di gestione dell'energia, già ampiamente diffuso in altre aree europee;
- in Italia, le disposizioni relative alle CER di cui alla Direttiva RED II hanno trovato preliminare attuazione con una disciplina transitoria e sperimentale (art. 42-bis del d.l. 162/2019 s.m.i.). Successivamente il d.lgs. 199/2021, ha recepito la Direttiva RED II e ha stabilizzato la disciplina relativa alle CER;
- nonostante ciò, in Italia le CER faticano a diffondersi e sono ancora pochissime quelle realmente attive o che stanno ricevendo gli incentivi statali erogati dal Gestore dei servizi elettrici (Gse). A pesare sul loro avvio si contano: lungaggini burocratiche, la mancanza degli incentivi da parte del Ministero dell'ambiente e della sicurezza energetica, il ritardo sull'emanazione delle regole attuative, che si uniscono alle difficoltà nel ricevere le registrazioni e il ricevimento degli incentivi o i preventivi onerosi per allacci alla rete. Risulta, infatti, ancora inattuata la disposizione contenuta nell'articolo 8 del d.lgs. 199/2021 che indicava 180 giorni per aggiornare i meccanismi di incentivazione, ovvero entro maggio 2022; nelle more per le CER trova applicazione la disciplina di promozione e di incentivazione transitoria di cui all'articolo 42-bis del decreto-legge n. 162 del 2019;
- il Ministero dell'ambiente e della sicurezza, pur avendo annunciato l'avvio dell'*iter* con l'Unione europea sulla proposta di decreto di cui al citato articolo 8 del d.lgs. 199/2021 che incentiva la diffusione di forme di autoconsumo di energia da fonti rinnovabili, pur rassicurando ciclicamente sul completamento imminente della normativa, non ha ancora fornito alcun chiarimento in relazione agli incentivi ed ai tempi di conclusione del procedimento.

Preso atto, altresì, che il Comune di Canegrate:

- è impegnato, attraverso molteplici progettualità ed interventi, sul tema del contrasto ai cambiamenti climatici, in coerenza con gli obiettivi della missione 2 del Piano Nazionale di Ripresa e Resilienza "*Rivoluzione verde e transizione ecologica*" in tema di efficientamento energetico degli edifici pubblici, efficientamento della gestione idrica e miglioramento della gestione delle acque di pioggia, mobilità sostenibile, ciclo dei rifiuti, utilizzo fonti rinnovabili, adattamento al cambiamento climatico dei territori;
- con delibera di Consiglio Comunale n. 23 del 5 aprile u.s. ha approvato all'unanimità la costituzione di comunità di energia rinnovabile, con la conseguente necessità di provvedere ad ogni azione utile a promuoverne la costituzione sul territorio comunale;
- in sede di prima attuazione di tale deliberazione, il 30 maggio u.s. si è svolto un partecipato incontro avente ad oggetto le CER, alla presenza di relatori qualificati, con l'obiettivo di diffondere e favorire l'istituzione delle stesse;
- in coerenza con la previsione dell'art. 7 dello Statuto intende continuare nell'attività di programmazione e realizzazione, anche mediante l'accesso a risorse economiche regionali, statali e comunitarie, delle azioni di contrasto agli effetti negativi del cambiamento climatico, di riduzione dell'inquinamento e del consumo di fonti di energia non rinnovabili, anche mediante l'istituzione e l'avvio dei primi impianti CER.

Tutto ciò premesso, rilevato e considerato, questo Consiglio Comunale:

- esprime la propria preoccupazione e la propria contrarietà ai ritardi continui con cui si procede nella definizione dell'impianto normativo nazionale fondamentale per la trasformazione del nostro

COMUNE DI CANEGRATE (MILANO)

modello di approvvigionamento energetico da fossile a rinnovabile e in particolare a quelli necessari per completare il sistema di incentivazione e regolazione per la realizzazione delle CER;

- auspica come necessaria la celere definizione dei citati provvedimenti attuativi del decreto legislativo n. 199 del 2021 riguardanti la disciplina dell'autoconsumo e delle comunità energetiche.
- riafferma la necessità di assicurare una capillare attivazione delle CER assicurando il pieno e totale supporto.

E, pertanto, impegna il Sindaco e la Giunta:

- a sollecitare il Governo affinché metta in campo politiche e maggiori risorse per programmare e realizzare una vera conversione ecologica nell'interesse dei cittadini e dell'ambiente, partendo dal rifinanziamento dei nove progetti del Pnrr che sono stati eliminati dal Piano, anche attraverso altre fonti di finanziamento, e dalla definizione dei provvedimenti attuativi sopra ricordati in merito alle CER;
- a rappresentare in tutte le sedi necessarie il punto di vista espresso dal Consiglio Comunale, trasmettendo questo atto di indirizzo al Presidente della Repubblica, al Presidente del Consiglio dei ministri, ai Presidenti di Camera e Senato, ai gruppi parlamentari di Camera e Senato, al Presidente della Regione e ai gruppi consiliari regionali.

Davide Spirito – *consigliere comunale "Canegrate Insieme"*
Stefano Sapone - *consigliere comunale "Canegrate Insieme"*

Allegato alla deliberazione
C.C. n. 75 del 27/11/2023 SUB B)

MATTEO MODICA
SINDACO

ORDINE DEL GIORNO

"Conversione ecologica e contrasto ai cambiamenti climatici"

Premesso che

- l'Italia è frequentemente attraversata da eventi climatici estremi caratterizzati da elevate temperature, incendi, nubifragi, grandinate anomale e violente trombe d'aria che hanno colpito diversi territori da nord a sud, in un crescendo di frequenza e di intensità, causando vittime e feriti, oltre che ingenti danni economici e ambientali;
- anche in Canegrate, lo scorso 24 luglio, si è verificato un evento meteorico eccezionale ed imprevedibile, con violenti scrosci di pioggia, tromba d'aria e grandine di rilevanti dimensioni, che hanno provocato ingenti danni sull'intero territorio comunale e sugli edifici di proprietà pubblica e privata;
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COMUNE DI CANEGRATE (MILANO)

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- il Ministero dell'ambiente e della sicurezza, pur avendo annunciato l'avvio dell'*iter* con l'Unione europea sulla proposta di decreto di cui al citato articolo 8 del d.lgs. 199/2021 che incentiva la diffusione di forme di autoconsumo di energia da fonti rinnovabili, pur rassicurando ciclicamente sul completamento imminente della normativa, non ha ancora fornito alcun chiarimento in relazione agli incentivi ed ai tempi di conclusione del procedimento;
- continuano ad esserci ritardi continui ed incomprensibili sulle CER che danneggiano pesantemente il nostro Paese e un'assenza di risposte sulle promesse fatte in relazione ai 2,2 miliardi di euro a fondo perduto per le CER nei comuni sotto i 5.000 abitanti con l'attivazione di oltre quindicimila nuovi impianti.

Preso atto, altresì, che il Comune di Canegrate:

- è impegnato, attraverso molteplici progettualità ed interventi, sul tema del contrasto ai cambiamenti climatici, in coerenza con gli obiettivi della missione 2 del Piano Nazionale di Ripresa e Resilienza "*Rivoluzione verde e transizione ecologica*" in tema di efficientamento energetico degli edifici pubblici, efficientamento della gestione idrica e miglioramento della gestione delle acque di pioggia, mobilità sostenibile, ciclo dei rifiuti, utilizzo fonti rinnovabili, adattamento al cambiamento climatico dei territori;
- con delibera di Consiglio Comunale n. 23 del 5 aprile u.s. ha approvato all'unanimità la costituzione di comunità di energia rinnovabile, con la conseguente necessità di provvedere ad ogni azione utile a promuoverne la costituzione sul territorio comunale;
- in sede di prima attuazione di tale deliberazione, il 30 maggio u.s. si è svolto un partecipato incontro avente ad oggetto le CER, alla presenza di relatori qualificati, con l'obiettivo di diffondere e favorire l'istituzione delle stesse;
- in coerenza con la previsione dell'art. 7 dello Statuto intende continuare nell'attività di programmazione e realizzazione, anche mediante l'accesso a risorse economiche regionali, statali e comunitarie, delle azioni di contrasto agli effetti negativi del cambiamento climatico, di riduzione dell'inquinamento e del consumo di fonti di energia non rinnovabili, anche mediante l'istituzione e l'avvio dei primi impianti CER.

Tutto ciò premesso, rilevato e considerato, questo Consiglio Comunale:

- esprime la propria preoccupazione e la propria contrarietà ai ritardi continui con cui si procede nella definizione dell'impianto normativo nazionale fondamentale per la trasformazione del nostro modello di approvvigionamento energetico da fossile a rinnovabile e in particolare a quelli necessari per completare il sistema di incentivazione e regolazione per la realizzazione delle CER;
- auspica come necessaria la celere definizione dei citati provvedimenti attuativi del decreto legislativo n. 199 del 2021 riguardanti la disciplina dell'autoconsumo e delle comunità energetiche.
- riafferma la necessità di assicurare una capillare attivazione delle CER assicurando il pieno e totale supporto.

E, pertanto, impegna il Sindaco e la Giunta:

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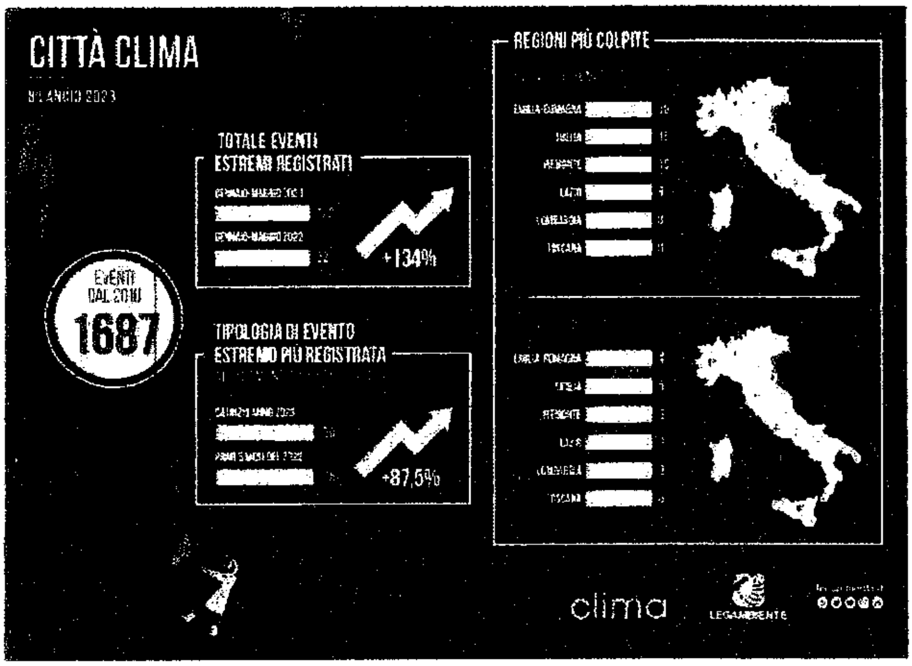
- a rappresentare in tutte le sedi necessarie il punto di vista espresso dal Consiglio Comunale, trasmettendo questo atto di indirizzo al Presidente della Repubblica, al Presidente del Consiglio dei ministri, ai Presidenti di Camera e Senato, ai gruppi parlamentari di Camera e Senato, al Presidente della Regione e ai gruppi consiliari regionali.

Davide Spirito – *consigliere comunale "Canegrate Insieme"*
Stefano Sapone - *consigliere comunale "Canegrate Insieme"*

città | LEGAMBIENTE

HOME CHI SIAMO NEWS APPROFONDIMENTI CONTATTI MAPPA

I nuovi dati Città Clima in occasione della Giornata Mondiale dell'Ambiente

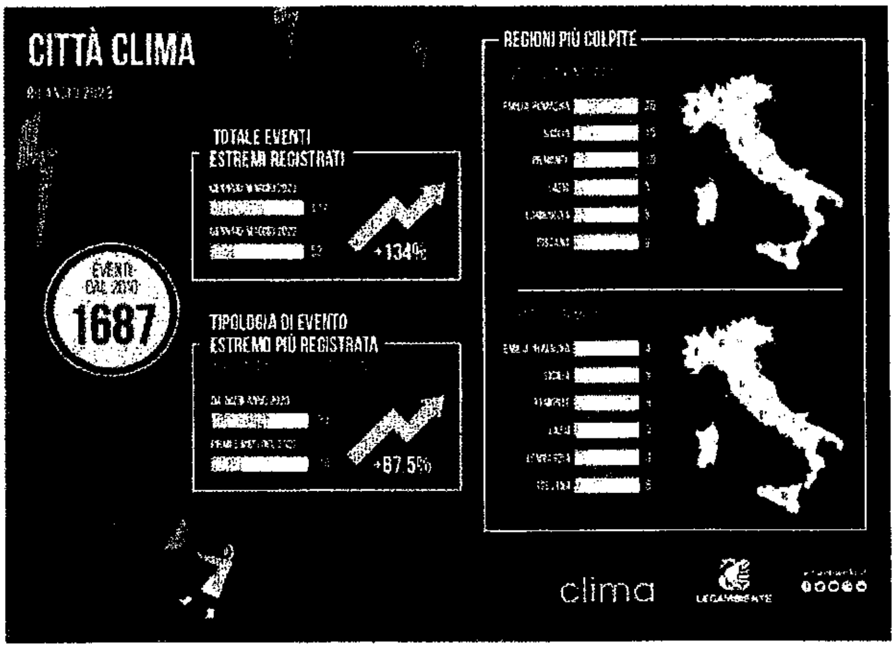


Cerca...

Articoli recenti

Trend in crescita degli eventi meteo-[illegible] nei primi cinque mesi del 2023 [illegible] con +134% rispetto agli stessi mesi del 2022.

[illegible] registrati 122 fenomeni meteorologici [illegible]. Tra le regioni più colpite Emilia-Romagna, Sicilia e Piemonte.



Gli allagamenti da piogge intense sono la tipologia che si è verificata con più frequenza con 30 eventi contro i 16 dei primi 5 mesi del 2022 segnando [illegible] +87,5%.

Legambiente, in occasione della Giornata Mondiale dell'Ambiente, vuole lanciare un messaggio chiaro al Governo Meloni. [illegible] Piano di adattamento climatico di cui il nostro Paese è ancora sprovvisto, prevedendo risorse adeguate; aggiornando entro fine giugno il PNIEC; approvando una legge contro il consumo di suolo che l'Italia attende da 11 anni. [illegible] A livello europeo, per Legambiente, è importante che si definisca subito un Patto di solidarietà per il clima [illegible]

Il Piano di adattamento è [illegible]

PNIEC [illegible]

Commenti recenti

Archivi

Comune di Canegrate prot. n. 0016619 del 20-11-2023 Cat 2 Cl. 3

COMUNE DI CANEGRATE (MILANO)

europea e nazionale in grado di contribuire a contenere il surriscaldamento del pianeta entro la soglia critica di 1,5°C e fronteggiare l'emergenza climatica. L'Italia in sintesi deve fare la sua parte con una revisione del suo PNIEC andando ben oltre il [illegible] obiettivo climatico nazionale del 51% proposto nel PNRR per il 2030.

L'Italia può colmare l'attuale ritardo (dal recente rapporto dell'ISPRA sugli scenari emissivi dell'Italia emerge che nel 2030 con le politiche correnti potremo raggiungere una riduzione delle emissioni climalteranti di appena il 33% rispetto ai livelli del 1990 e contro il [illegible] 65%) grazie soprattutto al contributo dell'efficienza energetica e delle rinnovabili. In questa partita è fondamentale anche [illegible] transizione energetica, prevedendo il *phase-out* dei sussidi alle fonti fossili entro il 2030, liberando così importanti risorse finanziarie da investire nello sviluppo delle rinnovabili e dell'efficienza energetica. E poi accelerare la decarbonizzazione dei trasporti, la mobilità elettrica può e deve fare la differenza.

Legge sul consumo di suolo [illegible] 2030

Speciale Giornata Mondiale Ambiente [illegible]

[illegible]

Condividi questo contenuto!

Post correlati

nature medicine

Article

https://doi.org/10.1038/s41591-023-02419-z

Heat-related mortality in Europe during the summer of 2022

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Over 70,000 excess deaths occurred in Europe during the summer of 2003. The resulting societal awareness led to the design and implementation of adaptation strategies to protect at-risk populations. We aimed to quantify heat-related mortality burden during the summer of 2022, the hottest season on record in Europe. We analyzed the Eurostat mortality database, which includes 45,184,044 counts of death from 823 contiguous regions in 35 European countries, representing the whole population of over 543 million people. We estimated 61,672 (95% confidence interval (CI) = 37,643–86,807) heat-related deaths in Europe between 30 May and 4 September 2022. Italy (18,010 deaths; 95% CI = 13,793–22,225), Spain (11,324; 95% CI = 7,908–14,880) and Germany (8,173; 95% CI = 5,374–11,018) had the highest summer heat-related mortality numbers, while Italy (295 deaths per million, 95% CI = 226–364), Greece (280, 95% CI = 201–355), Spain (237, 95% CI = 166–312) and Portugal (211, 95% CI = 162–255) had the highest heat-related mortality rates. Relative to population, we estimated 56% more heat-related deaths in women than men, with higher rates in men aged 0–64 (+41%) and 65–79 (+14%) years, and in women aged 80+ years (+27%). Our results call for a reevaluation and strengthening of existing heat surveillance platforms, prevention plans and long-term adaptation strategies.

Anthropogenic emissions of greenhouse gases have led to a detectable rise in global temperatures, which is associated with an increase in the frequency and intensity of heat waves and hot summers. Globally, the last 8 years have been the warmest on record, and 2022 was the fifth warmest year. In this context, Europe emerges as a major climatic hotspot, given that warming since preindustrial levels is almost 1 °C higher than the corresponding global increase, and higher than in any other continent. Moreover, climate change projections for the continent indicate that temperatures, and their health impacts, will rise at an accelerated rate unless strong mitigation and adaptation actions are put in place.

Exposure to heat poses a major threat to high-risk populations in Europe and worldwide by substantially contributing to increased morbidity and mortality. Heat waves are the extreme weather events with the highest impact in terms of attributable counts of death. Heat-related mortality has been a major concern for the past two decades in Europe, especially after the 71,449 excess deaths registered during the months of June, July, August and September of 2003 (ref. [illegible]). The resulting societal awareness of the short-term health effects of heat led to the design and implementation of heat prevention plans and other adaptation strategies to protect at-risk populations

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across the continent, that is, older adults with preexisting cardiovascular and respiratory diseases, women and socially isolated or socioeconomically disadvantaged individuals. Although there is some evidence that heat prevention plans, including preparedness and response strategies, intervention actions and heat-health early warning systems, can reduce the health burden of ambient temperatures, the evidence of their effectiveness is still limited.

The summer of 2022 was the hottest season on record in Europe, characterized by an intense series of heat waves, which led to extremes in terms of temperature, drought and fire activity. The record-breaking temperatures during the summer of 2022 were monitored by existing surveillance systems, activating an array of national and regional heat prevention and adaptation plans. The European Statistical Office, Eurostat, reported unusually high excess mortality rates for the summer of 2022 (ref. 26), but so far the heat-related mortality burden has not been quantified across the European continent. The aim of this study was to use epidemiological models to estimate the sex- and age-specific mortality burden associated with the record-breaking temperatures registered during the 14-week period between 30 May and 4 September 2022 (weeks 22–35). Moreover, we compared this mortality burden within the broader context of the summer of 2003 and the accelerated warming observed in the continent during the last decade (2013–2022).

Results

Association between temperature and mortality

The cumulative temperature–mortality association in Europe shows a monotonically increasing risk of death for temperatures above and below the minimum mortality temperature (Fig. 1a,b; associations by sex and age groups available in Extended Data Fig. 1a–d). This optimum temperature was around 17–19 °C, with small differences according to sex (18.32 °C for women and 18.55 °C for men), but generally warmer values for older adults (17.39, 18.33 and 18.56 °C for the age groups 0–64, 65–79 and 80+ years, respectively). The slopes of the relative risk (RR) association for temperatures colder and hotter than the optimum temperature also increased with age (Fig. 1b); however, the age risk pattern differed according to sex (Extended Data Fig. 1b–d). On the one hand, the slope for colder temperatures was similar in women and men, except in the age group 0–64 years, in which the risk was higher in men. On the other hand, the slope for hotter temperatures was steeper in men aged 0–64 years and in women aged 65–79 and 80+ years. The overall spatial distribution of the RR at the temperature 95th centile emphasizes the latitudinal differences in heat-related mortality risk (Fig. 1c). Thus, the highest risks of heat-related mortality were observed in countries near the Mediterranean Sea in all sex and age groups, with generally higher values for older adults (Fig. 1c) and women (Fig. 1e,f).

Temperatures and heat-related mortality numbers

Observed European mean temperatures uninterruptedly exceeded the baseline climatological values of the 1991–2020 period in all of the weeks during summer 2022 (Fig. 2a). European weekly temperature anomalies in 2022 ranged between +0.78 and +2.33 °C in June (weeks 22–26), between +0.18 and +3.56 °C in July (weeks 26–30), and between +0.91 and +2.67 °C in August (weeks 31–35). Although several subcontinental warmer-than-average weeks were recorded during the summer (Extended Data Figs. 2–6), the most intense, pan-European heat wave was observed during week 29 (between 18 and 24 July): this week alone was estimated to be associated with 11,637 (95% confidence interval (CI) = 7,639–15,970) heat-related deaths (Fig. 2b), particularly in Central and Southern Europe (Extended Data Fig. 4c,d). The largest temperature anomalies coincided with the peak of the mean annual cycle of temperatures, that is, from mid-July to mid-August (Fig. 2a). The joint effect of the annual cycle and the anomalies magnified the mortality numbers and was associated with 38,881 (95% CI = 25,051–53,699) heat-related deaths between 11 July and 14 August (Fig. 2b). Heat-related mortality during this 5-week period accounted for nearly two-thirds of the overall summer (61,672; 95% CI = 37,643–86,807; Table 1) and annual (62,862; 95% CI = 37,935–88,780; Supplementary Table 1) heat-related mortality numbers. Italy (18,010; 95% CI = 13,793–22,225), Spain (11,324; 95% CI = 7,908–14,880), Germany (8,173; 95% CI = 5,374–11,018), France (4,807; 95% CI = 1,739–8,123), the United Kingdom (3,469; 95% CI = 370–6,676) and Greece (3,092; 95% CI = 2,217–3,915) were the countries with the highest summer heat-related deaths (Table 1).

We estimated 63% more heat-related deaths in women (35,406; 95% CI = 21,576–46,634) than in men (21,667; 95% CI = 14,684–27,998) during the summer of 2022 (Table 1 and Supplementary Table 2). The death toll steeply increased with age, with 4,822 (95% CI = 1,130–8,158), 9,226 (95% CI = 665–17,382) and 36,848 (95% CI = 27,591–45,509) heat-related deaths in the age groups 0–64, 65–79 and 80+ years, respectively (Table 2). Italy, Spain, Germany and France had the highest female and male heat-related mortality numbers (Table 1). Italy had the highest number of heat-related deaths among the age groups 65–79 and 80+ years, but France had the highest number of heat-related deaths among people aged 0–64 years (Table 2). Despite differences in the magnitude of overall summer mortality numbers among different sex and age groups, the weekly changes in heat-related deaths were generally the same in all of them (Fig. 2b,c; weekly changes according to sex and age groups are available in Extended Data Fig. 1e–h). The differences according to sex largely varied with age, with higher heat-related deaths in men aged 0–64 years (+43%), but in women aged 65–79 (+6%) and 80+ (+121%) years (Supplementary Table 2).

Temperatures and heat-related mortality rates

Recorded summer mean temperatures exceeded the baseline climatological values in all European countries with the only exception being Iceland (−0.43 °C; Fig. 3a). The warmest summer temperature anomalies were mainly registered in Southwestern Europe, with the highest national values in France (+2.43 °C), Switzerland (+2.30 °C), Italy (+2.28 °C), Hungary (+2.13 °C) and Spain (+2.11 °C). The highest summer heat-related mortality rates were found in countries near the Mediterranean Sea, that is, Italy (295 deaths per million, 95% CI = 226–364), Greece (280, 95% CI = 201–355), Spain (237, 95% CI = 166–312) and Portugal (211, 95% CI = 162–255; Table 1), as well as in specific regions in Bulgaria, Romania, Croatia and Southern France (Fig. 3b). Overall, we estimated 114 (95% CI = 69–160) heat-related deaths per million in Europe during the summer, with 145 (95% CI = 89–192) female and 93 (95% CI = 63–120) male deaths per million (Table 1). The heat-related mortality rate also steeply increased with age, with 16 (95% CI = 4–27), 160 (95% CI = 12–302) and 1,684 (95% CI = 1,261–2,080) deaths per million in the age groups 0–64, 65–79 and 80+ years, respectively (Table 2). The differences according to sex largely varied with age, with higher heat-related mortality rates in men aged 0–64 (+41%) and 65–79 (+14%) years, and in women aged 80+ years (+27%) and for all age groups combined (+56%; Supplementary Table 2). These age-dependent sex differences were found in most countries with, for example, higher heat-related mortality rates in men than in women for the age group 65–79 years (Fig. 3c,d), but higher in women than in men for people aged 80+ years (Fig. 3e,f).

Climate change and the summer of 2022

On average over the 35 European countries analyzed here, the summer of 2022 was the warmest season on record (20.30 °C = $\mu + 2.51\sigma$), which exceeded both the summer of 2003 (20.20 °C = $\mu + 2.36\sigma$) and the threshold of 2.5 s.d. (σ = 0.67 °C) over the mean (μ = 18.62 °C) of the distribution of summer mean temperatures during the 1991–2020 period. The summer of 2003 was an exceptionally warm season within a period of relatively constant global and continental temperatures, commonly referred to as the global warming hiatus of 1998–2012 (ref. 27) (Fig. 4a). During the last decade (2013–2022), however, summer

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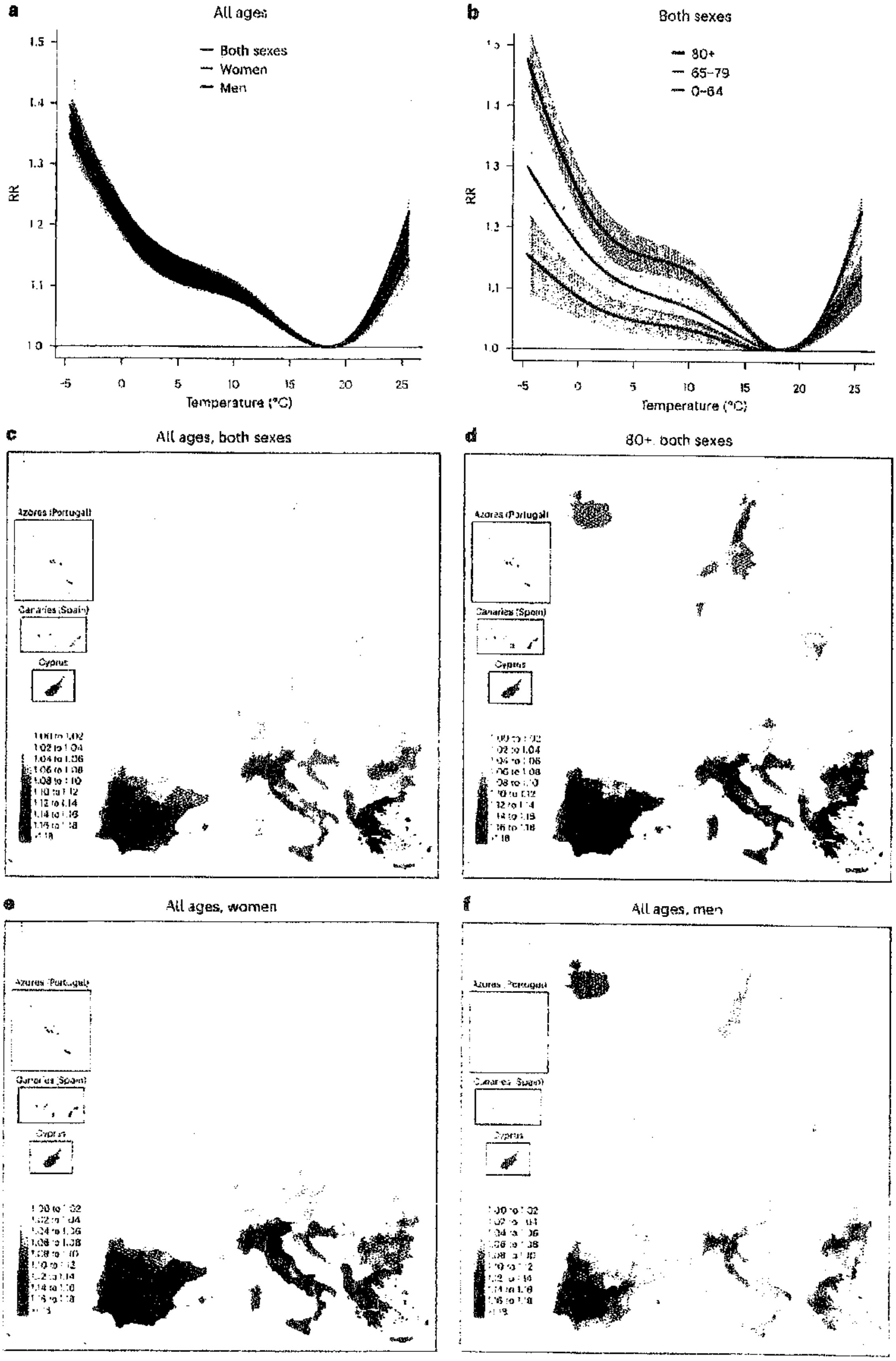

Fig. 1 | Temperature-related risk of death during 2015–2019. a,b, Cumulative relative risk of death (unitless) in Europe for the overall population (black), women (red) and men (blue) (**a**) and people aged 0–64 (blue), 65–79 (red) and 80+ (black) years (**b**), together with their 95% CIs (shadings). **c–f**, Regional relative risk of death (unitless) at the temperature 95th centile for the overall population (**c**), people aged 80+ years (**d**), women (**e**) and men (**f**).

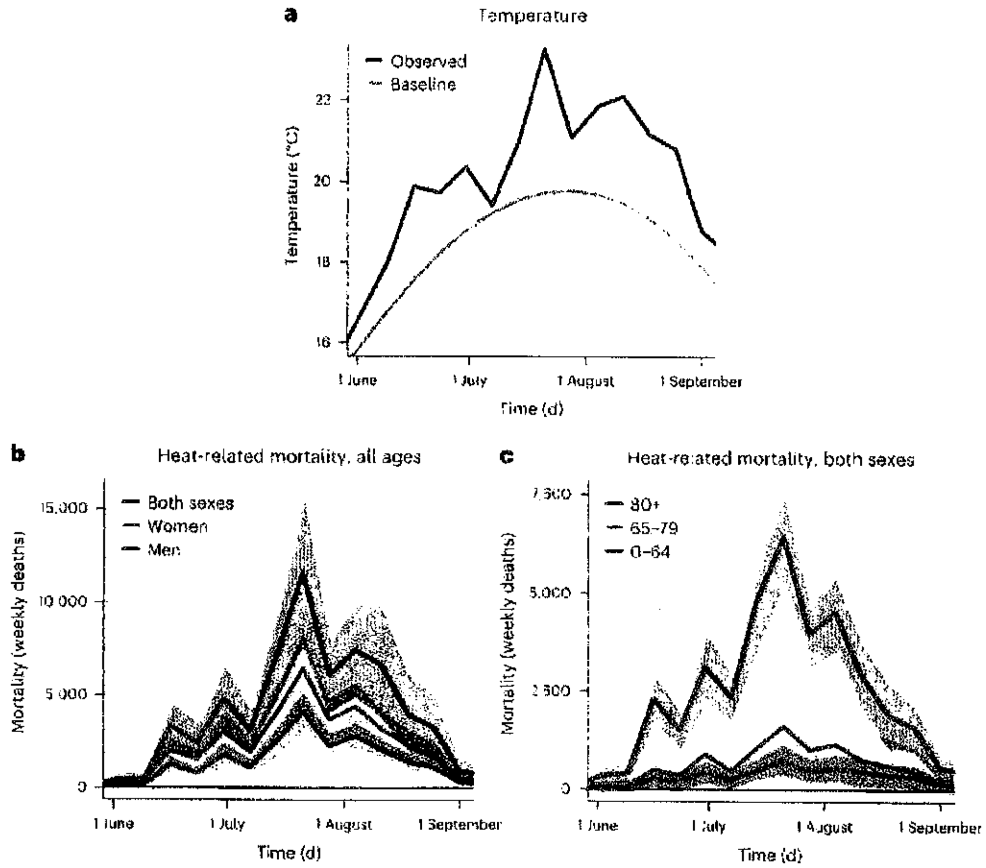

Fig. 2 | Weekly temperature and heat-related mortality numbers in Europe during the summer of 2022. a, Weekly baseline (gray line) and observed (black line) temperature (°C) averaged over Europe. Temperature anomalies are defined as the difference between observed and baseline temperatures (gray shading). Baseline temperatures were computed as the mean annual cycle of observed temperatures in the reference period 1991–2020. **b**,**c**, Weekly heat-related mortality (weekly deaths) aggregated over Europe for the overall population (black), women (red) and men (blue) (**b**) and people aged 0–64 (blue), 65–79 (red) and 80+ (black) years (**c**), together with their 95% CIs (shadings). The numbers for women and men in **b** do not include the United Kingdom; values for the age groups in **c** do not include Germany, Ireland and the United Kingdom.

mean temperatures in the analyzed European countries sped up at an approximately constant rate of +0.142 °C per year, compared with the modest rate of +0.028 °C per year in 1991–2012 (the slopes in Fig. 4a). In that regard, although summer mean temperatures in 2022 followed the trend observed in the last decade (Fig. 4a), this was associated with an increase in 25,561 summer heat-related deaths compared to 2015–2021 (Fig. 4b). In this regard, we estimated that the warming observed since 2015 was associated with 18,547 additional summer heat-related deaths for every +1 °C increase in temperature (the slope in Fig. 4b), or in relative terms, 35.3 additional summer heat-related deaths per million for every +1 °C increase in temperature. Moreover, in the absence of adaptation to future summer warming, and by forward extrapolating the linear fittings in Fig. 4a,b, we would expect a heat-related mortality burden of 68,116 deaths on average every summer by the year 2030, 94,363 deaths by 2040 and 120,610 deaths by 2050.

Sensitivity analyses

We performed sensitivity analyses by modifying the modeling choices (Methods). In the main results, we calibrated the epidemiological models with temperature and mortality data from January 2015 to December 2019 to avoid any eventual interfering effect of the coronavirus disease 2019 pandemic. However, sensitivity analyses showed that estimates of the RRs and heat-related mortality during the summer (68,476 deaths; 95% CI = 44,884–90,803) and year (70,997; 95% CI = 46,612–94,777) of 2022 were only slightly higher when the pandemic period was included in the calibration of the epidemiological models, that is, 2015–2022 (Supplementary Table 1 and Extended Data Fig. 7).

The statistical analysis was done in two steps (Methods). In the first stage, we used quasi-Poisson regression models to calculate the location-specific temperature–lag–mortality relationship in each European region. We tested different configurations of the exposure–response function, being estimates of the heat-related mortality not sensitive to these choices (Supplementary Table 1). In the main results, we used the model configuration that better fitted the data based on the Akaike information criterion. In the second stage, we used a multivariate, multilevel meta-regression analysis to pool the location-specific coefficients obtained in the first step, including (1) country random effects and (2) the location-specific temperature average, (3) the temperature interquartile range and (4) the percentage of people aged 80+ years as meta-predictors (Extended Data Fig. 8). We tested these meta-predictors and we found that they explained a significant fraction of the spatial heterogeneity (Supplementary Table 3).

Discussion

This European-wide study quantified the mortality associated with record-breaking temperatures during the summer of 2022, currently the hottest season on record in Europe, and analyzed it within the broader context of the summer of 2003 and the accelerated warming observed in the continent during the last decade (2013–2022). Epidemiological models were applied to a mortality database representing the whole

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Table 1 | National sex-specific heat-related mortality numbers and rates during the summer of 2022

Country	Attributable number (deaths)			Attributable rate (deaths per million)		
	Overall	Women	Men	Overall	Women	Men
Albania	352 (97, 586)	186 (39, 336)	80 (4, 155)	117 (32, 195)	125 (26, 225)	53 (2, 102)
Austria	**419 (109, 741)**	**274 (−55, 570)**	**199 (66, 332)**	**47 (12, 83)**	**60 (−12, 125)**	**45 (15, 75)**
Belgium	434 (−26, 911)	264 (−68, 558)	159 (−26, 341)	38 (−2, 79)	45 (−12, 95)	28 (−5, 60)
Bulgaria	**1,277 (549, 2,072)**	**678 (138, 1,145)**	**556 (239, 867)**	**176 (75, 285)**	**182 (37, 307)**	**157 (68, 245)**
Switzerland	302 (48, 557)	255 (54, 433)	93 (20, 161)	35 (6, 64)	58 (12, 99)	22 (5, 37)
Cyprus	**101 (24, 173)**	**56 (6, 110)**	**47 (17, 75)**	**113 (27, 193)**	**123 (13, 240)**	**107 (38, 171)**
Czechia	279 (−25, 607)	290 (37, 520)	36 (−45, 122)	26 (−2, 56)	53 (7, 95)	7 (−8, 23)
Germany	**8,173 (5,374, 11,018)**	**3,925 (1,656, 6,403)**	**2,771 (1,333, 4,149)**	**98 (64, 132)**	**93 (39, 152)**	**68 (32, 101)**
Denmark	252 (42, 468)	119 (−51, 274)	59 (−19, 136)	43 (7, 80)	41 (−17, 93)	20 (−7, 47)
Estonia	**167 (26, 296)**	**113 (7, 214)**	**39 (−5, 83)**	**123 (19, 217)**	**157 (9, 297)**	**61 (−8, 129)**
Greece	3,092 (2,217, 3,915)	2,076 (1,551, 2,586)	822 (448, 1,186)	280 (201, 355)	367 (274, 457)	153 (83, 220)
Spain	**11,324 (7,908, 14,880)**	**7,190 (4,426, 9,478)**	**4,250 (2,825, 5,633)**	**237 (166, 312)**	**295 (182, 389)**	**181 (121, 241)**
Finland	225 (−94, 562)	278 (−15, 551)	30 (−14, 71)	40 (−17, 100)	98 (−5, 194)	11 (−5, 26)
France	**4,807 (1,739, 8,123)**	**2,424 (−473, 4,964)**	**2,584 (1,237, 3,889)**	**73 (26, 124)**	**71 (−14, 146)**	**81 (39, 122)**
Croatia	731 (346, 1,069)	469 (198, 708)	212 (72, 344)	172 (82, 252)	213 (90, 322)	104 (35, 168)
Hungary	**513 (−126, 1,207)**	**529 (74, 915)**	**129 (−131, 396)**	**51 (−13, 121)**	**101 (14, 175)**	**27 (−27, 83)**
Ireland	26 (−168, 199)	38 (−90, 174)	0 (0, 0)	5 (−34, 40)	15 (−35, 69)	0 (0, 0)
Iceland	**0 (0, 0)**	**0 (−2, 3)**	**0 (0, 0)**	**0 (0, 0)**	**2 (−12, 17)**	**0 (0, 0)**
Italy	18,010 (13,793, 22,225)	11,917 (8,078, 15,148)	6,268 (4,619, 7,817)	295 (226, 364)	379 (257, 482)	211 (156, 264)
Liechtenstein	**1 (−2, 3)**	**1 (−1, 3)**	**0 (0, 0)**	**19 (−42, 73)**	**41 (−56, 143)**	**0 (−10, 11)**
Lithuania	381 (158, 618)	157 (−13, 309)	190 (94, 282)	128 (53, 208)	99 (−8, 194)	138 (68, 204)
Luxembourg	**44 (−1, 91)**	**25 (−1, 51)**	**7 (−7, 20)**	**69 (−2, 144)**	**79 (−3, 162)**	**22 (−21, 62)**
Latvia	105 (−33, 242)	42 (−69, 144)	46 (−20, 111)	52 (−16, 120)	39 (−63, 133)	49 (−21, 120)
Montenegro	**50 (−12, 108)**	**31 (−17, 83)**	**7 (−8, 21)**	**81 (−19, 173)**	**100 (−55, 262)**	**22 (−26, 69)**
Malta	76 (−2, 150)	41 (−11, 90)	43 (12, 72)	147 (−5, 290)	166 (−43, 363)	160 (43, 270)
Netherlands	**469 (−8, 981)**	**326 (−117, 727)**	**155 (−49, 357)**	**27 (0, 56)**	**37 (−13, 82)**	**18 (−6, 41)**
Norway	30 (−32, 86)	8 (−43, 58)	28 (−2, 57)	5 (−6; 16)	3 (−16, 22)	10 (−1, 21)
Poland	**763 (−283, 1860)**	**559 (−417, 1446)**	**259 (−73, 576)**	**20 (−7, 48)**	**28 (−21, 73)**	**14 (−4, 31)**
Portugal	2,212 (1,703, 2,679)	1,227 (761, 1,618)	828 (592, 1,064)	211 (162, 255)	222 (138, 293)	166 (119, 214)
Romania	**2,455 (1,201, 3,797)**	**1,130 (56, 2,145)**	**1,323 (779, 1,837)**	**122 (60, 189)**	**110 (5, 209)**	**135 (79, 187)**
Serbia	574 (226, 955)	465 (244, 651)	253 (89, 415)	81 (32, 135)	129 (68, 180)	74 (26, 121)
Sweden	**40 (−104, 200)**	**46 (−100, 181)**	**9 (−30, 50)**	**4 (−10, 19)**	**9 (−19, 35)**	**2 (−6, 10)**
Slovenia	154 (−24, 307)	100 (−4, 209)	58 (−4, 119)	73 (−12, 146)	96 (−4, 200)	55 (−3, 112)
Slovakia	**365 (62, 676)**	**164 (−5, 314)**	**128 (−12, 267)**	**66 (11, 123)**	**58 (−2, 111)**	**48 (−4, 99)**
United Kingdom	3,469 (370, 6,676)	Not available	Not available	52 (6, 100)	Not available	Not available
Europe	**61,672 (37,643, 86,807)**	**35,406 (21,576, 48,634)**	**21,667 (14,684, 27,998)**	**114 (69, 160)**	**145 (89, 192)**	**93 (63, 120)**

Summer refers to the 14-week period between 30 May and 4 September 2022 (weeks 22–35). Values in parentheses represent the 95% CIs. The numbers and rates for women and men do not include the United Kingdom.

population of over 543 million people from 823 contiguous regions in 35 European countries. Overall, we estimated 62,862 heat-related deaths in Europe in 2022; 61,672 of those deaths occurred between 30 May and 4 September. Italy, Spain, Germany, France, the United Kingdom and Greece had the highest summer heat-related mortality numbers. In relative terms, the largest summer heat-related mortality rates were found in countries near the Mediterranean Sea, which included Italy, Greece, Spain and Portugal. The results showed that there was a large increase in heat-related mortality during June–August 2022, approaching the record-breaking excess mortality of June–September 2003.

However, the comparison with 2003 needs to be interpreted with caution, given the large methodological differences in our study compared to previous estimates[illegible]. First, the estimate of the death toll during the summer of 2003 from Robine et al.[illegible] was based on excess mortality numbers, which quantify the deviation of the mortality from the seasonally varying expected mortality from a reference period. As heat-related mortality occurs every summer, the estimate of excess deaths may exclude part of the heat-related mortality burden. On the other hand, this study used epidemiological models to quantify deaths specifically attributable to heat; therefore, our estimate is not

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Table 2 | National age-specific heat-related mortality numbers and rates during the summer of 2022

	Attributable number (deaths)			Attributable rate (deaths per million)		
Country	**0–64**	**65–79**	**80+**	**0–64**	**65–79**	**80+**
Albania	24 (−18, 67)	48 (−19, 115)	165 (75, 246)	9 (−7, 26)	138 (−54, 330)	2,845 (1,283, 4,226)
Austria	52 (−27, 124)	160 (18, 303)	213 (−32, 472)	7 (−4, 17)	130 (15, 246)	423 (−63, 939)
Belgium	67 (−54, 171)	56 (−229, 324)	357 (113, 599)	7 (−6, 18)	34 (−141, 199)	554 (176, 931)
Bulgaria	108 (10, 197)	445 (135, 746)	737 (255, 1,237)	20 (2, 37)	384 (116, 644)	2,271 (787, 3,812)
Switzerland	34 (−68, 125)	67 (−126, 255)	230 (−71, 542)	5 (−10, 18)	56 (−106, 214)	487 (−151, 1,149)
Cyprus	9 (−6, 23)	15 (−8, 37)	72 (16, 119)	12 (−8, 31)	135 (−67, 325)	2,018 (459, 3,334)
Czechia	14 (−25, 49)	41 (−61, 144)	236 (12, 465)	2 (−3, 6)	24 (−35, 84)	522 (27, 1,030)
Germany	Not available	Not available	Not available	Not available	Not available	Not available
Denmark	43 (2, 83)	70 (−74, 215)	77 (−64, 218)	9 (0, 18)	78 (−82, 237)	265 (−219, 747)
Estonia	28 (16, 37)	32 (−10, 73)	71 (3, 138)	26 (15, 35)	167 (−52, 379)	885 (33, 1,719)
Greece	158 (6, 305)	321 (−10, 649)	2,245 (1437, 3054)	20 (1, 38)	198 (−6, 401)	2,977 (1,905, 4,050)
Spain	796 (189, 1,357)	1,476 (357, 2,544)	9,436 (5,855, 12,563)	21 (5, 36)	222 (54, 383)	3,273 (2,031, 4,357)
Finland	18 (−14, 49)	67 (−22, 156)	107 (−124, 337)	4 (−3, 11)	71 (−24, 164)	325 (−375, 1,019)
France	1,007 (171, 1,747)	1,673 (−87, 3,443)	2,832 (4, 5,395)	19 (3, 34)	169 (−9, 348)	706 (1, 1,346)
Croatia	30 (−43, 94)	160 (26, 289)	467 (189, 712)	10 (−14, 31)	244 (40, 440)	2,209 (892, 3,364)
Hungary	17 (−36, 69)	255 (−48, 547)	449 (15, 891)	2 (−5, 9)	165 (−31, 354)	1,009 (35, 2,000)
Ireland	Not available	Not available	Not available	Not available	Not available	Not available
Iceland	2 (−14, 17)	1 (−11, 11)	0 (0, 0)	6 (−44, 53)	14 (−264, 255)	0 (0, 0)
Italy	965 (236, 1,670)	2,326 (1,026, 3,601)	14,821 (12,004, 17,483)	21 (5, 37)	244 (108, 377)	3,290 (2,664, 3,880)
Liechtenstein	0 (0, 0)	0 (−1, 1)	0 (−1, 1)	2 (−8, 11)	38 (−111, 186)	147 (−577, 792)
Lithuania	77 (27, 123)	80 (4, 154)	211 (61, 367)	34 (12, 55)	199 (9, 383)	1,334 (383, 2,325)
Luxembourg	7 (−1, 15)	6 (−7, 19)	17 (−12, 42)	13 (−2, 28)	87 (−99, 265)	657 (−467, 1,636)
Latvia	11 (−13, 30)	9 (−36, 53)	129 (30, 221)	7 (−9, 20)	34 (−128, 190)	1,135 (261, 1,949)
Montenegro	5 (−9, 17)	12 (−9, 33)	25 (−10, 55)	9 (−17, 32)	146 (−120, 412)	1,248 (−496, 2,752)
Malta	14 (0, 30)	15 (−12, 39)	43 (−11, 84)	34 (−1, 70)	189 (−151, 498)	1,895 (−473, 3,740)
Netherlands	143 (1, 286)	129 (−303, 582)	306 (161, 440)	10 (0, 20)	48 (−113, 218)	359 (188, 516)
Norway	84 (−153, 270)	43 (−62, 146)	0 (−7, 8)	19 (−34, 61)	57 (−83, 196)	1 (−28, 33)
Poland	275 (−362, 844)	70 (−188, 328)	525 (205, 829)	9 (−12, 28)	13 (−35, 61)	310 (121, 489)
Portugal	192 (76, 303)	379 (129, 617)	1,464 (937, 1,947)	24 (10, 38)	219 (74, 357)	2,036 (1,302, 2,706)
Romania	457 (131, 757)	780 (67, 1,466)	1,186 (318, 2,108)	30 (9, 49)	273 (23, 513)	1,400 (375, 2,489)
Serbia	112 (15, 206)	300 (94, 506)	174 (−36, 394)	21 (3, 38)	264 (83, 445)	560 (−115, 1,269)
Sweden	22 (−27, 64)	64 (−118, 252)	16 (−76, 114)	3 (−3, 8)	41 (−76, 161)	29 (−136, 204)
Slovenia	9 (−26, 39)	34 (−18, 85)	94 (−1?, 186)	5 (−15, 23)	105 (−54, 260)	798 (−91, 1,580)
Slovakia	42 (−3, 83)	90 (−99, 275)	145 (−36, 337)	9 (−1, 19)	119 (−130, 362)	790 (−195, 1,834)
United Kingdom	Not available	Not available	Not available	Not available	Not available	Not available
Europe	**4,822 (1,130, 8,158)**	**9,226 (665, 17,382)**	**36,848 (27,591, 45,509)**	**16 (4, 27)**	**160 (12, 302)**	**1,684 (1,261, 2,080)**

Summer refers to the 14-week period between 30 May and 4 September 2022 (weeks 22–35). The values in parentheses represent the 95% CIs. The numbers and rates do not include Germany, Ireland and the United Kingdom.

expected to include mortality cases in which heat was not a contributor. Furthermore, we used weekly temperature and mortality data in our epidemiological models, which is expected to underestimate the day-to-day variability of the time series and possibly their lagged short-term associations. This is especially the case for heat, given that the risk of death is acute and generally does not last for more than 5 days. As a reference, a previous study applied similar epidemiological models to daily temperature and mortality data for Spain only, and found that the summer heat-related mortality burden was 6% higher (that is, 12,054 deaths) than the one reported here for the same country (that is, 11,324 deaths). Finally, the excess mortality estimates during the summer of 2003 from Robine et al. were based on data from only 16 European countries, representing a population of nearly 400 million people. As a reference, when restricted to the same regions and countries, our heat-related mortality estimates for the summer of 2022 (that is, 61,672 deaths) were 15% lower (that is, 52,121 deaths).

Furthermore, the warming levels and trends observed immediately before the summers of 2003 and 2022 were also very different. The summer of 2003 was an exceptionally rare event, even if the observed long-term anthropogenic warming was taken into account.

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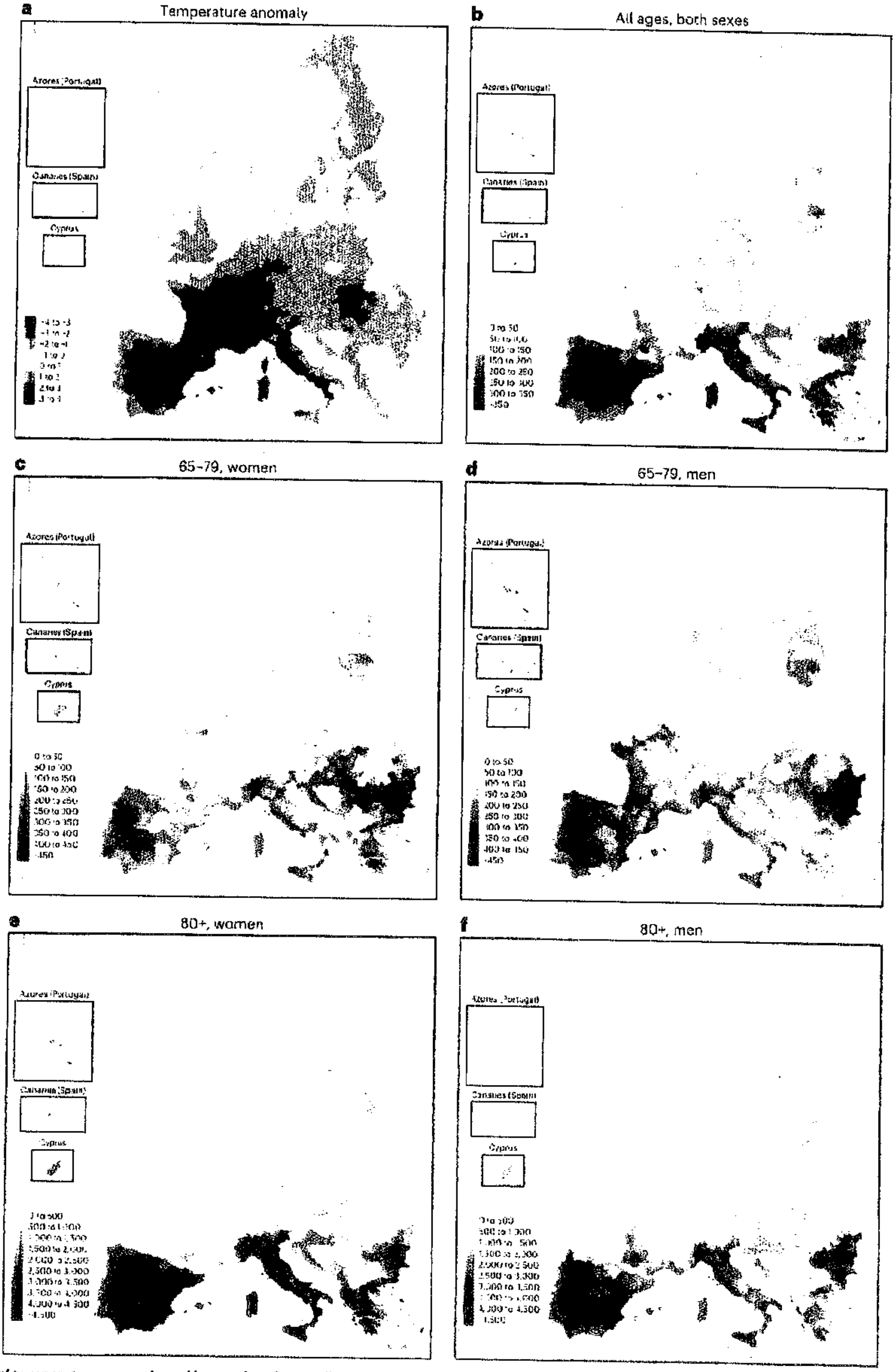

Fig. 3 | Regional temperature anomaly and heat-related mortality rate during the summer of 2022. **a**, Regional temperature anomaly (°C) averaged over the summer. **b**–**f**, Regional heat-related mortality rate (summer deaths per million) aggregated over the summer for the whole population (**b**), women aged 65–79 years (**c**), men aged 65–79 years (**d**), women aged 80+ years (**e**) and men aged 80+ years (**f**). Summer refers to the 14-week period between 30 May and 4 September 2022 (weeks 22–35).

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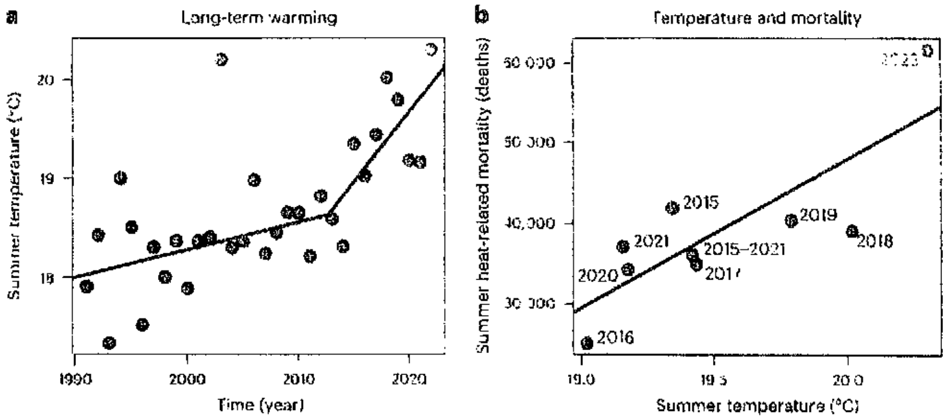

Fig. 4 | The summer of 2022 within the context of rising temperatures in Europe. **a**, Year-to-year time series of summer mean temperatures (°C) averaged over the analyzed European countries. The straight lines depict the linear fitting for the 1991–2012 (excluding the year 2003) and 2013–2022 periods. **b**, Relationship between summer mean temperature (°C) and summer heat-related mortality (summer deaths) in the analyzed European countries. The straight line shows the linear fitting for the 2015–2022 period.

The exceptional nature of the event highlighted the shortcomings (or the inexistence) of heat prevention plans during the time, the fragility of health systems in dealing with climate-related health emergencies and the lack of awareness of the associated risks and impacts by the media and general population. Instead, the temperatures in the summer of 2022 were not exceptional, in the sense that this could have been anticipated by forward extrapolation of the accelerated warming pathway observed during the last decade (2013–2022). Yet, this was associated with an increase of over 25,500 summer heat-related deaths compared to the 2015–2021 period. The rate of warming observed during the last decade emphasizes the urgent need for reevaluation and strengthening of adaptation strategies. Indeed, in the absence of further adaptation to the summer heat, and by forward extrapolating the linear fittings in Fig. 4a,b, we would expect a rapid increase to unprecedented summer heat-related mortality numbers in the coming years. However, the exceptional nature of 2003, with summer mean temperatures more than +2 °C warmer than the values expected from previous summers (Fig. 4a), leads to the speculation of what would have been the mortality burden during the summer of 2022 if a similar temperature anomaly had occurred. Although future studies are needed to answer this question, the possibility that a severe thermal anomaly with regard to the current warmer climate could produce an impact on mortality greater than the one observed in 2022 needs to be carefully considered in the next summers.

Although previous studies showed that the risk of death due to heat has decreased in several European countries, our results suggest that past efforts toward an effective early adaptation response to observed warming, including preparedness and response strategies, intervention actions and heat-health early warning systems, had largely been insufficient to prevent the large magnitude of the heat-related mortality estimated for the summer of 2022. Despite the experience accumulated since 2003 (ref. 23), and the excess mortality estimates captured by EuroMOMO and Eurostat in several European countries, the magnitude of the overall death toll received relatively little attention. Despite the fact that many European countries activated heat prevention plans during the summer of 2022, the estimation of over 60,000 heat-related deaths suggests that prevention plans were only partially effective.

The burden of heat-related mortality was higher among women. Relative to population, we estimated 56% more heat-related deaths in women than in men, with higher rates in men aged 0–64 and 65–79 years, and in women aged 80+ years. Physiological differences and sociocultural factors have been suggested as potential explanations for these gaps, but we also found that differences in age structure between men and women partly explained the higher risk for women at advanced ages and for men at younger ages. Prevention plans should also target a reduction of sex, age and other drivers of inequalities in the risk of heat-related mortality.

This study included an analysis of heat-related risks and mortality numbers according to sex and age groups, showing generally higher values in women and, as expected, steeply increased with age. We showed that age composition was a driver of between-sex and between-country differences; this could closely relate to policy questions around how to efficiently protect the population from summer heat. Exposure to extreme heat, especially during summers such as in 2022, may differentially exacerbate preexisting or chronic risks among women and men in each age group. This raises questions about whether the observed sex differences in heat-related mortality risks and numbers are driven by differences or disparities, and what this would mean for policy, which is beyond the scope of the study and its methodological design. The combination of sex and age, socioeconomic level, education and underlying health status could have contributed to the magnitude and distribution of heat-related mortality in our study. Unfortunately, with the current data availability in Europe, the analysis of the societal determinants of vulnerability and adaptation will require a larger effort. Improving data availability for more granular pan-European studies to monitor the health and inequity dimensions of climate change should also be considered as part of the societal response to the climate crisis, as already emphasized by Robine et al. 15 years ago.

Temperatures during the summer of 2022 were warmer than average in most of Europe, but the largest summer heat-related mortality rates were found in countries near the Mediterranean Sea. We showed that this latitudinal pattern closely resembled the spatial distribution of RRs, rather than the distribution of temperature anomalies (Figs. 1c and 3a,b). This mismatch was already observed during the summer of 2003, with the warmest summer mean temperature anomalies in Central Europe, mainly in France and Switzerland, but the largest excess mortality in Spain (+13.7%), France (+11.8%) and Italy (+11.6%). Our study therefore emphasized the vulnerability of populations in Southern Europe. As a major climate change hotspot, these populations will be increasingly exposed to extreme summer conditions and would therefore be expected to experience increasingly higher heat-related mortality in the future. Addressing geographical inequalities in current and future vulnerability to heat will also need to be prioritized by national and European governments and agencies.

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This study has some limitations worth acknowledging. First, we used weekly temperature and mortality data in the epidemiological models, which is expected to underestimate the heat-related mortality of the summer of 2022. The scientific question of characterizing the biases of epidemiological models applied to weekly temperature and mortality data was beyond the scope of the present work and it will be addressed in a follow-up study. Second, data according to sex and age groups were not available in a reduced number of countries, that is, the United Kingdom, Ireland and Germany, which emphasized the urgent need to coordinate national agencies for statistics to create protocols integrating and homogenizing health data sources and improving open-access data for research, translation and policymaking. In our opinion, this should be a priority in the agenda of European governments, both from inside and outside the European Union, given that health data are managed at the country level and only integrated as open-access data in exceptional cases. Finally, the study analyzed records of all-cause mortality because cause-specific data were not available. This limitation is important because some of the differences in heat-related mortality risks and numbers between sex and age groups could be better interpreted within the framework of an in-depth analysis of the causes of death.

Due to global warming, temperatures in Europe are rising at a faster rate than the global average[3]. Taking into account the magnitude of heat-related mortality on the continent, our results call for a reevaluation and strengthening of heat surveillance platforms, prevention plans and long-term adaptation strategies. The high heat-related mortality that Europe experienced during the summer of 2022 calls for national governments and relevant agencies in the European Union and continental levels to increase the ambition and effectiveness of heat prevention and adaptation plans with urgency.

Online content

Any methods, additional references, Nature Portfolio reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at https://doi.org/10.1038/s41591-023-02419-z.

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Methods

Data sources

We obtained weekly counts of all-cause mortality according to sex and age groups from Eurostat[46]. Missing data were complemented by contacting the corresponding national agencies for statistics. The final dataset included 45,184,044 counts of death (22,000,519 for women and 21,913,050 for men) between January 2015 and November 2022 from 823 contiguous regions representing over 543 million Europeans in 35 countries, namely Albania (12 regions), Austria (35), Belgium (44), Bulgaria (28), Croatia (1), Cyprus (1), Czechia (14), Denmark (11), Estonia (5), Finland (19), France (96), Germany (16), Greece (52), Hungary (20), Iceland (2), Ireland (1), Italy (103), Latvia (6), Liechtenstein (1), Lithuania (10), Luxembourg (1), Malta (1), Montenegro (1), the Netherlands (40), Norway (11), Poland (73), Portugal (25), Romania (42), Serbia (25), Slovakia (8), Slovenia (1), Spain (59), Sweden (21), Switzerland (26), and the United Kingdom (12). On average, each region represented a population of 660,000 Europeans. All-age data according to sex was not available in the United Kingdom and only at the country level in Germany. Data according to sex and age groups was not available for Germany, Ireland and the United Kingdom.

We transformed the hourly gridded 2-m temperature data from the high-resolution ERA5-Land reanalysis[47] into weekly regional averages of daily mean 2-m temperature.

Statistical analysis

In a nutshell, we used the regional temperature and mortality time series for the period from January 2015 to December 2019 to calibrate the epidemiological models, which were then used to transform the temperature and mortality time series from January 2015 to November 2022 into the weekly and summer heat-related mortality numbers over the years 2015–2022. Epidemiological models were fitted separately for each combination of sex and age groups.

More specifically, the statistical analysis was done in two stages. In the first stage, we used quasi-Poisson regression models, which allow for overdispersed counts of deaths, to calculate the location-specific temperature–lag–mortality relationship in each European region. The models included (1) an intercept, (2) a natural cubic spline of time with 8 d.f. per year to control for the seasonal and long-term trends, and (3) a cross-basis function to estimate the exposure–lag–response association between weekly temperatures (temp) and mortality counts (mort):

log(E(mort)) =

intercept + ns(time, 8 d.f. per year) + crossbasis(temp; 0, 1, 2, 3 weeks)

The lag–response function of the cross-basis was modeled with integer lag values of 0, 1, 2 and 3 weeks, and the exposure–response function with a natural cubic spline with three internal knots at the 10th, 50th and 90th centiles of the location-specific weekly temperature distribution.

In the second stage, we used a multivariate, multilevel meta-regression analysis to pool the location-specific coefficients obtained in the first stage. The meta-regression included (1) the country random effects, (2) the location-specific temperature average, (3) the temperature interquartile range and (4) the percentage of people aged 80+ years as meta-predictors (Extended Data Fig. 8). We derived the best linear unbiased predictions of the temperature–mortality relationship in each region from the meta-regression to obtain the location-specific minimum mortality temperature and to transform the regional temperature and mortality time series from January 2015 to November 2022 into the weekly and summer heat-related mortality numbers over the years 2015–2022 (ref. 52). Heat-related mortality was calculated for the weeks with average temperatures above the location-specific minimum mortality temperature. Regional heat-related mortality numbers were aggregated to obtain the national and European burdens. Similarly, we computed 1,000 Monte Carlo simulations of the regional heat-related mortality numbers and separately aggregated the numbers in each simulation to calculate the 95% CIs at the national and continental levels. We calculated heat-related mortality rates (in deaths per million) by using the yearly regional population estimates from Eurostat.

We defined the temperature anomalies as the difference between observed and baseline temperatures. The baseline temperature was computed as the mean annual cycle of observed temperatures in the reference period 1991–2020, calculated as a linear regression model with temperature as the dependent variable, and (1) an intercept and (2) a natural cubic spline of day of the year with 6 d.f. as independent variables.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

This study is based on publicly available datasets: mortality counts from Eurostat (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Weekly_death_statistics&stable); temperature values from the European Centre for Medium-Range Weather Forecasts (https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land?tab=overview); and population numbers from Eurostat (https://ec.europa.eu/eurostat/cache/metadata/en/demo_r_gind3_esms.htm).

Code availability

The computer code illustrating the analyses is available at https://github.com/BallesterJoan/europe_summer_2022_heat.

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Author contributions

J.B. conceived the study. R.F.M.T. and F.P. collected, preprocessed and validated the data. J.B. and H.A. carried out the statistical analyses. J.B. wrote the first draft of the manuscript. M.Q.-Z., F.R.H., J.M.R., X.B., C.T., J.M.A. and H.A. contributed to subsequent versions, and to the interpretation of the data and results. All authors reviewed and approved the final version of the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

Extended data is available for this paper at https://doi.org/10.1038/s41591-023-02419-z.

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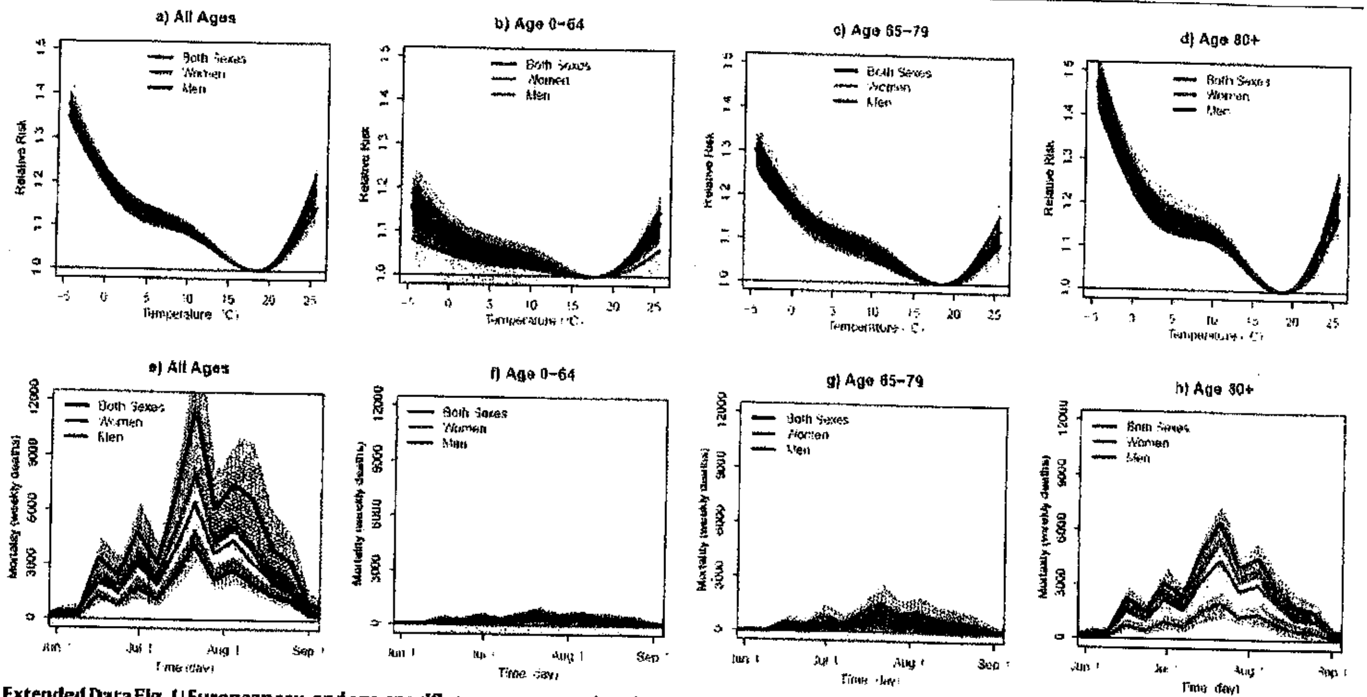

Extended Data Fig. 1 | European sex- and age-specific temperature-related risk of death and heat-related mortality. Panels (a-d) depict the cumulative relative risk of death (unitless) in Europe during 2015-2019. Panels (e-h) display the weekly heat-related mortality (weekly deaths) aggregated over Europe during the summer of 2022. The shadings represent the 95% confidence intervals. All-age data by sex was not available in the United Kingdom (red and blue lines in panels a,e). Data by sex and age groups was not available in the United Kingdom, Ireland and Germany (panels b-d, f-h).

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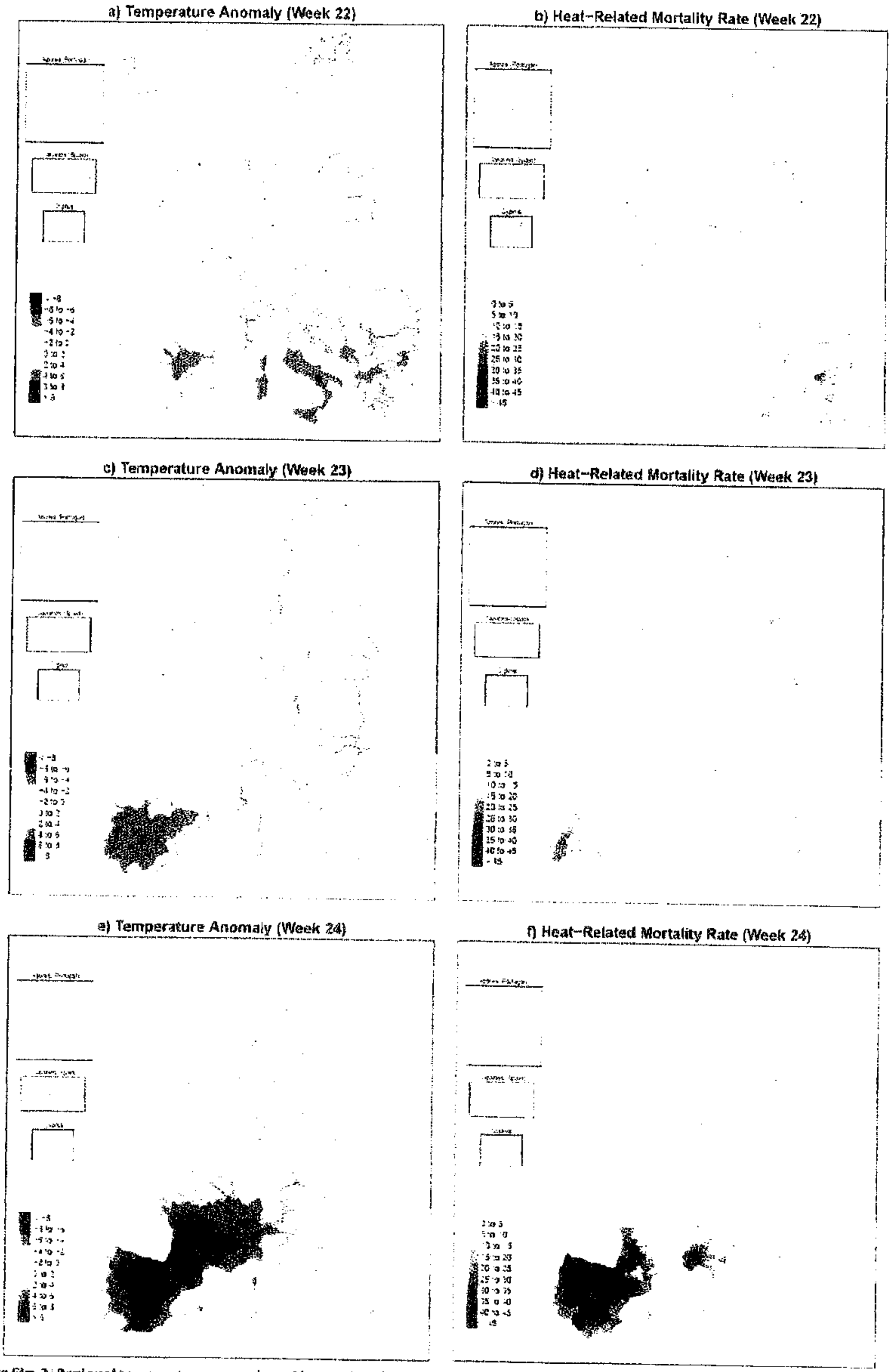

Extended Data Fig. 2 | Regional temperature anomaly and heat-related mortality rate during weeks 22, 23 and 24. Regional temperature anomaly (a,c,e; °C) and heat related mortality rate (b,d,f; weekly deaths per million) during weeks 22 (May 30 – June 5; a,b), 23 (June 6 – June 12; c,d) and 24 (June 13 – June 19; e,f) of the year 2022.

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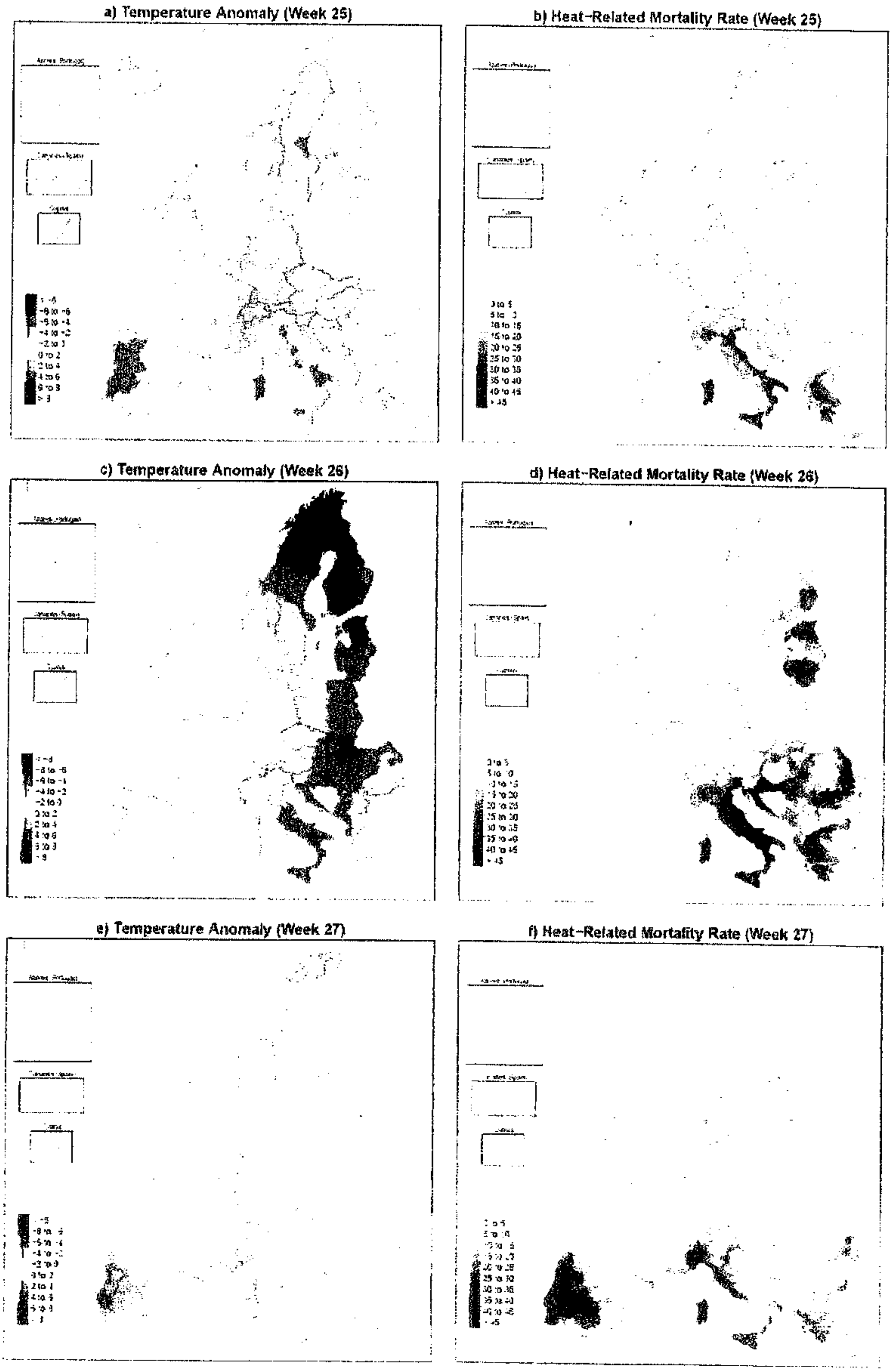

Extended Data Fig. 3 | Regional temperature anomaly and heat-related mortality rate during weeks 25, 26 and 27. Regional temperature anomaly (a,c,e: °C) and heat-related mortality rate (b,d,f: weekly deaths per million) during weeks 25 (June 20 - June 26: a,b), 26 (June 27 - July 3: c,d) and 27 (July 4 - July 10: e,f) of the year 2022.

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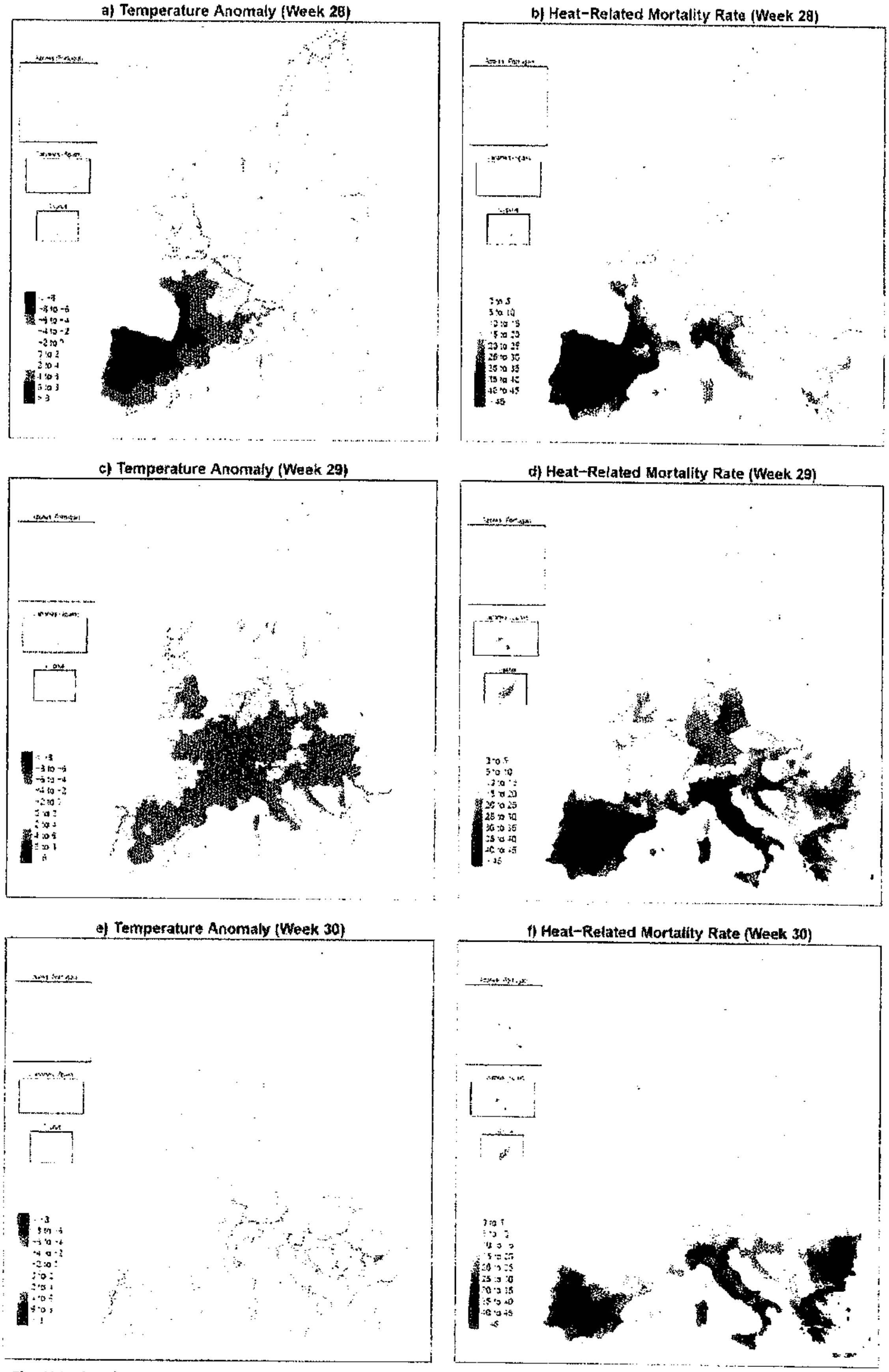
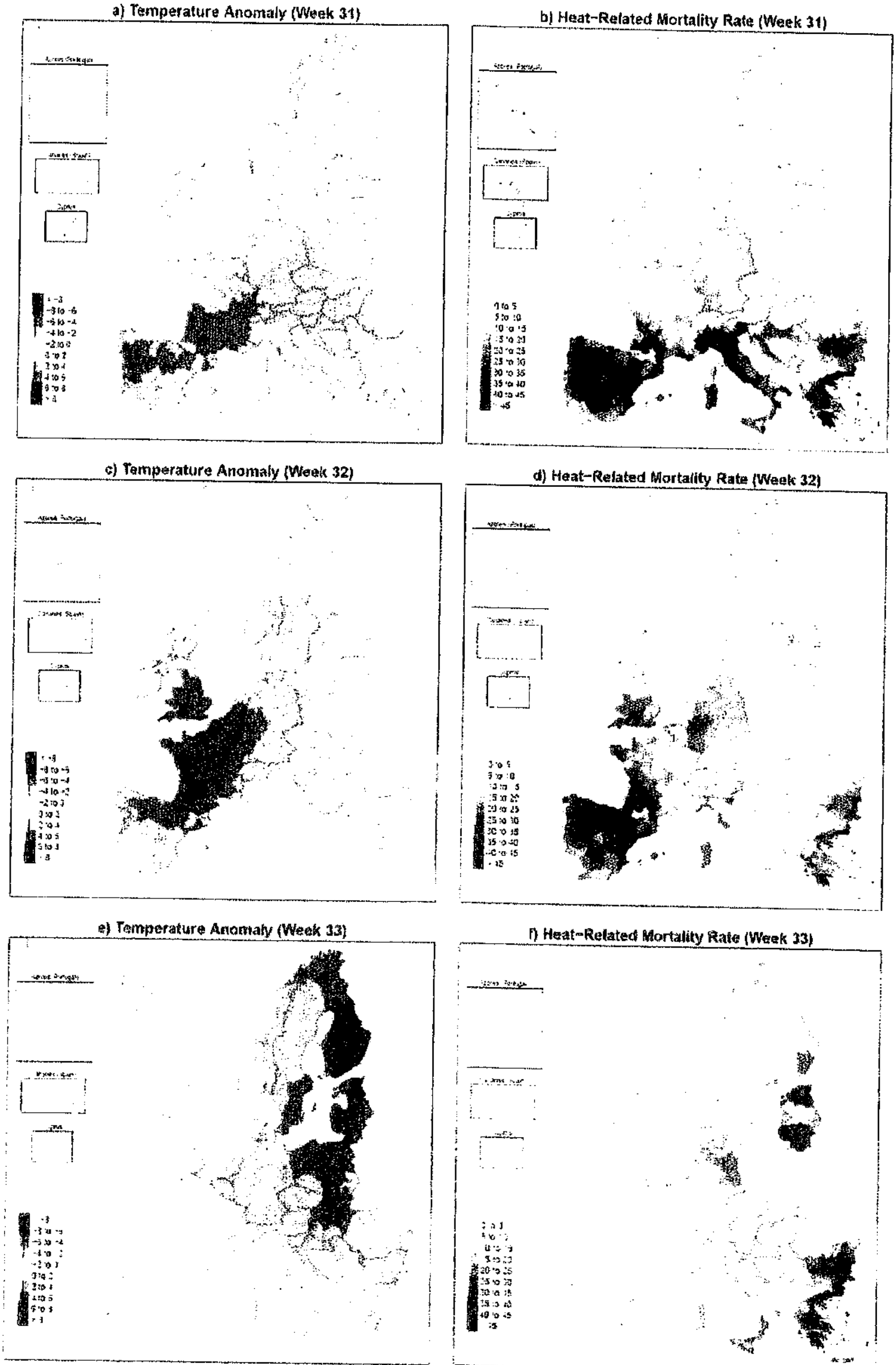


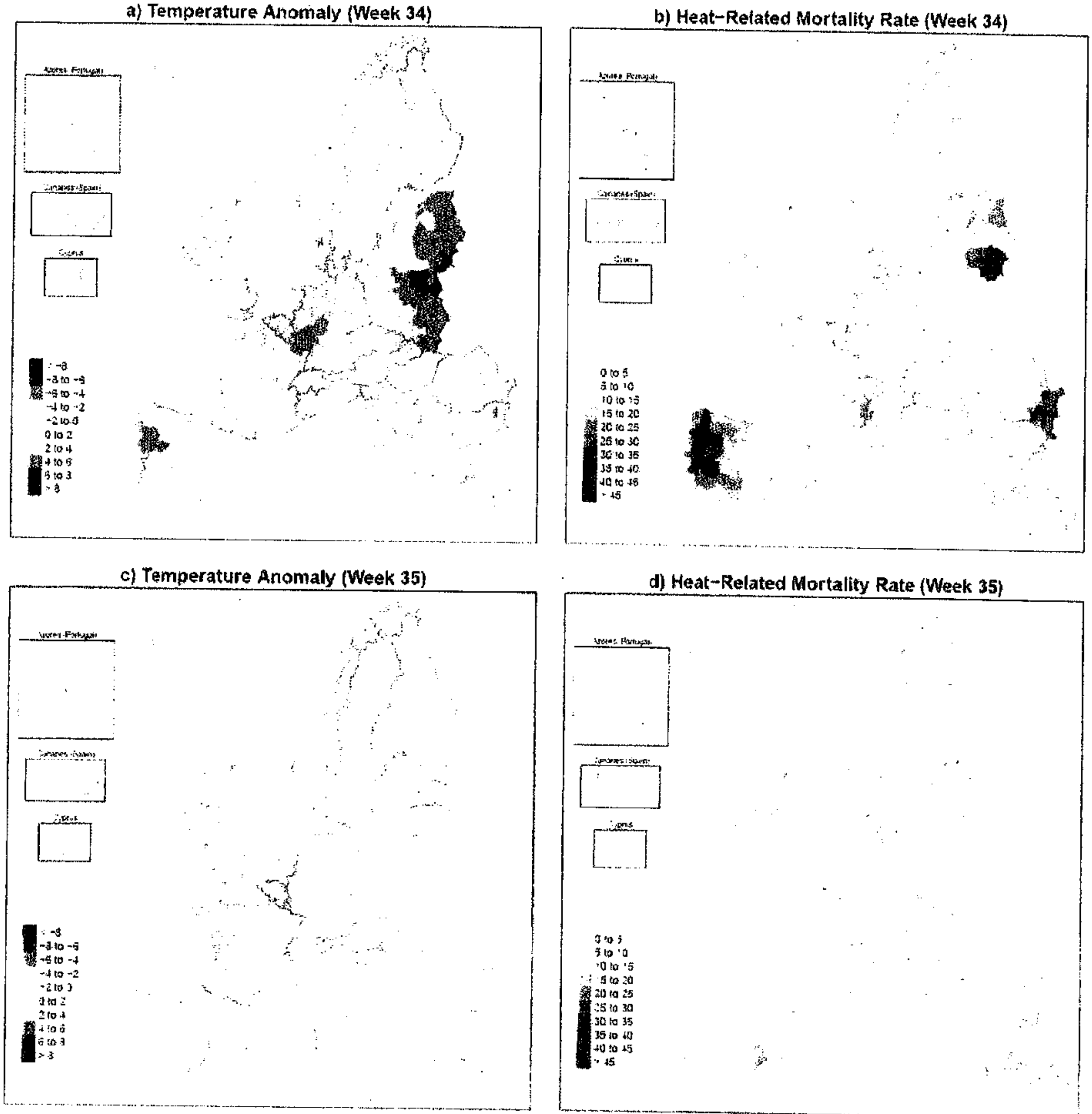
Extended Data Fig. 4 | Regional temperature anomaly and heat-related mortality rate during weeks 28, 29 and 30. Regional temperature anomaly (a,c,e; °C) and heat-related mortality rate (b,d,f; weekly deaths per million) during weeks 28 (July 11 - July 17; a,b), 29 (July 18 - July 24; c,d) and 30 (July 25 - July 31; e,f) of the year 2022.

https://doi.org/10.1038/s41591-023-02419-z



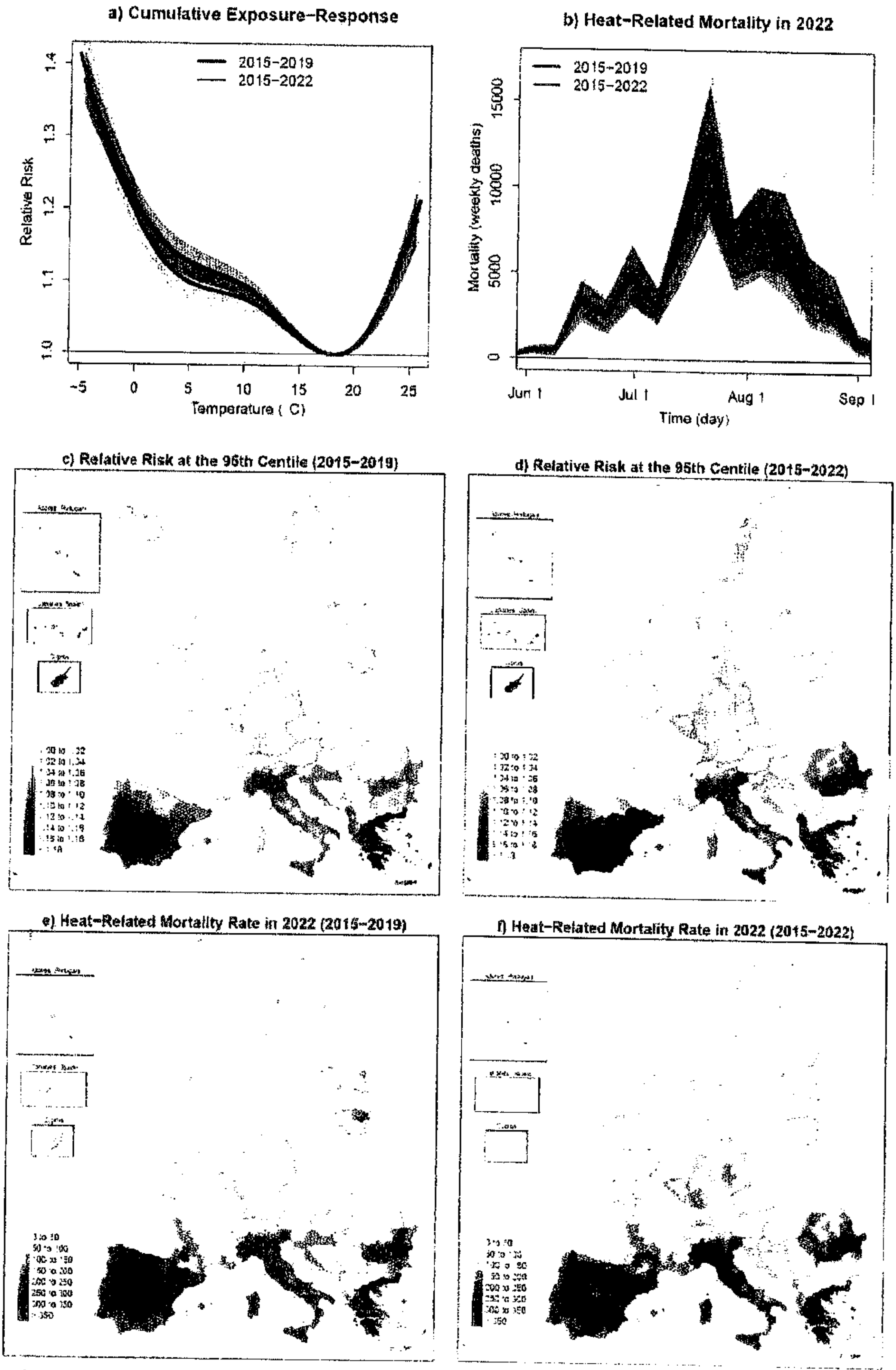
Extended Data Fig. 5 | Regional temperature anomaly and heat-related mortality rate during weeks 31, 32 and 33. Regional temperature anomaly (a,c,e; °C) and heat-related mortality rate (b,d,f; weekly deaths per million) during weeks 31 (August 1 – August 7; a,b), 32 (August 8 – August 14; c,d) and 33 (August 15 – August 21; e,f) of the year 2022.

https://doi.org/10.1038/s41591-023-02419-z



Extended Data Fig. 6 | Regional temperature anomaly and heat-related mortality rate during weeks 34 and 35. Regional temperature anomaly (a,c; °C) and heat-related mortality rate (b,d; weekly deaths per million) during weeks 34 (August 22 – August 28; a,b) and 35 (August 29 – September 4; c,d) of the year 2022.

https://doi.org/10.1038/s41591-023-02419-z

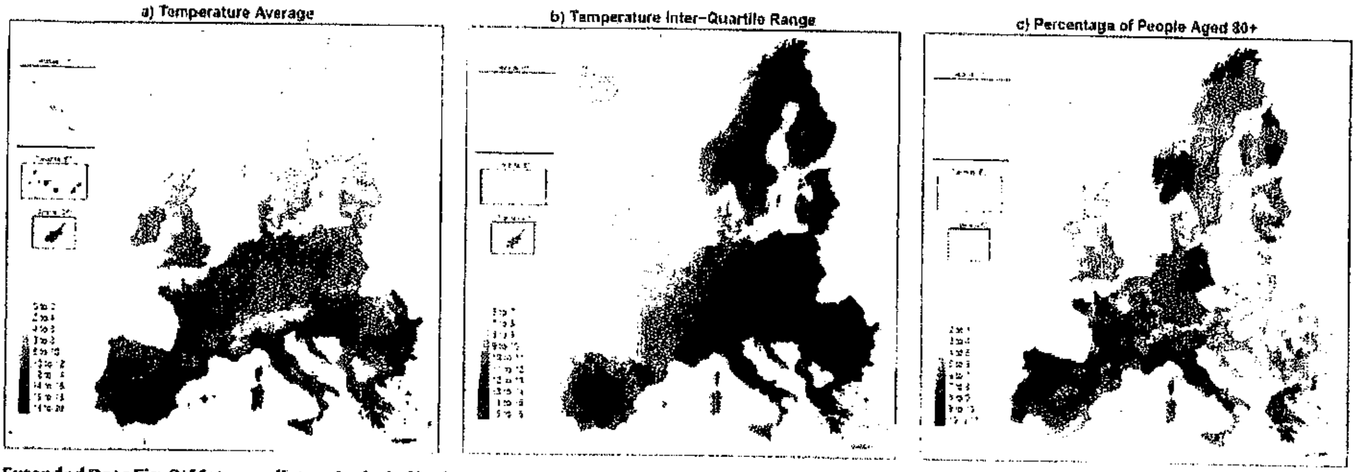


Extended Data Fig. 7 | See next page for caption.

https://doi.org/10.1038/s41591-023-02419-z

Extended Data Fig. 7 | Sensitivity to the period of calibration of the epidemiological associations. Panels (a,b) depict the cumulative relative risk of death (unitless) in Europe (a) and the weekly heat-related mortality (weekly deaths) aggregated over Europe during the summer of 2022 (b), together with their 95% confidence intervals (shadings). Panels (c-f) display the regional relative risk of death (unitless) at temperature 95th percentile (c,d) and the regional heat-related mortality rate (summer deaths per million) aggregated over the summer of 2022 (e,f). Values were obtained from epidemiological models calibrated with data from the periods 2015-2019 (black in a,b; and maps in c,e) and 2015-2022 (red in a,b; and maps in d,f). Summer refers to the 14-week period between May 30th and September 4th of 2022 (weeks 22-35).

https://doi.org/10.1038/s41591-023-02419-z



Extended Data Fig. 8 | Meta-predictors included in the meta-regression. Maps correspond to the regional temperature average (a, °C), temperature inter-quartile range (b, °C) and percentage of people aged 80+ years (c, %).

nature portfolio

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Last updated by author(s): May 19, 2023

Reporting Summary

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Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
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☒	☐	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Software and code

Data collection	This study is based on publicly available datasets, and data was directly downloaded from the official websites. No software was used for data collection.
Data analysis	The computer code illustrating the analyses is available at https://github.com/Ballesterjoan/europe_summer_2022_heat

Data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:
- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

This study is based on publicly available datasets: mortality counts from Eurostat (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Weekly_death_statistics&stable...), temperature values from ECMWF (https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-...?tab=overview), and population numbers from Eurostat (https://ec.europa.eu/eurostat/cache/metadata/en/demo_r_gind3_esms.htm).

Human research participants

[illegible]

Reporting on sex and gender	[illegible]
Population characteristics	Not applicable
Recruitment	Not applicable.
Ethics oversight	Not applicable.

[illegible]

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

[illegible]

Life sciences study design

[illegible]

Sample size	All counts of death (N = 45,184,044) were used
Data exclusions	No data was excluded.
Replication	Experimental findings are fully reproducible. Experiments were performed independently a number of times
Randomization	Not applicable due to the nature of the numerical calculations.
Blinding	Not applicable due to the nature of the numerical calculations.

Reporting for specific materials, systems and methods

[illegible]

Materials & experimental systems

n/a	Involved in the study	
☒	☐	Antibodies
☒	☐	Eukaryotic cell lines
☒	☐	Palaeontology and archaeology
☒	☐	Animals and other organisms
☒	☐	Clinical data
☒	☐	Dual use research of concern

Methods

n/a	Involved in the study	
☒	☐	ChIP-seq
☒	☐	Flow cytometry
☒	☐	MRI-based neuroimaging

Author Correction: Heat-related mortality in Europe during the summer of 2022

Correction to: *Nature Medicine*
https://doi.org/10.1038/s41591-023-02419-z.
Published online 10 July 2023.

https://doi.org/10.1038/s41591-023-02649-1

Published online: 24 October 2023

Check for updates

Joan Ballester, Marcos Quijal-Zamorano, Raúl Fernando Méndez Turrubiates, Ferran Pegenaute, François R. Herrmann, Jean Marie Robine, Xavier Basagaña, Cathryn Tonne, Josep M. Antó & Hicham Achebak

In the version of this article initially published, there was a typographical error in the second paragraph of the Discussion, where in the text now reading "As a reference, a previous study [*Epidemiology* **34**, e5–e6 (2023)] applied similar epidemiological models to daily temperature and mortality data for Spain only, and found that the summer heat-related mortality burden was 6% higher (that is, 12,054 deaths) than the one reported here...," 6% originally read "10%" and 12,054 originally read "12,504". The errors have been corrected in the HTML and PDF versions of the article.

Deliberazione C.C. n. 75 del 27 NOV. 2023

Letto, approvato e sottoscritto :

IL PRESIDENTE
F.to Matteo Modica

IL SEGRETARIO GENERALE
F.to Dr.ssa Teresa La Scala

CERTIFICATO DI PUBBLICAZIONE

Il sottoscritto Segretario certifica che copia della presente deliberazione, ai sensi dell'art.124 del D. Lgs. n.267/2000 viene pubblicata all'Albo Pretorio on line di questo Comune il giorno 13 DIC. 2023 e vi rimarrà per la durata di quindici giorni consecutivi.

Lì, 13 DIC. 2023

IL SEGRETARIO GENERALE
F.to (Dr.ssa Teresa La Scala)

AUTENTICAZIONE

La presente copia è conforme all'originale, per uso amministrativo, ai sensi del D.P.R. 28.12.2000 n.445, art.18, composta di n. 37 fogli.

Lì, 13 DIC. 2023

COMUNE DI CANEGRATE (MILANO)

IL SEGRETARIO GENERALE
(Dr.ssa Teresa La Scala)

CERTIFICATO DI ESECUTIVITA'

Si certifica che il presente atto è stato pubblicato nelle forme di legge all'Albo Pretorio del Comune ed è **DIVENTATO ESECUTIVO** in data ____________________ ai sensi dell'art.134, comma 3, del Decreto Legislativo 18.8.2000, n.267.

IL SEGRETARIO GENERALE
F.to Dr.ssa Teresa La Scala