Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Climate heat disasters fuel the health and care workforce crisis: a comparative assessment of workforce heat-health policy in selected European countries

Ellen Kuhlmann
e.kuhlmann@em.uni-frankfurt.de

Goethe-University Frankfurt
Michelle Falkenbach
WHO European Observatory on Health Systems and Policies
Katarzyna Dubas-Jakóbczyk
Institute of Public Health, Jagiellonian University Medical College, Kraków, Poland
Gunda Waldmann
Rechts- und Wirtschaftswissenschaftliche Fakultät, Lehrstuhl für Planetary and Public Health, University of Bayreuth, Bayreuth, Germany
Gabriela Lotta
Department of Public Administration, Fundação Getulio Vargas (FGV), São Paulo, Brazil
Tiago Correia
Universidade Nova de Lisboa, Lisbon, Portugal
Zuzana Kotherová
Institute of Public Health and Medical Law, First Faculty of Medicine, Charles University, Prague, Czech Republic
Stefano Neri
Department of Social and Political Sciences, University of Milan, Milan, Italy
Marius-Ionut Ungureanu
Department of Public Health, Faculty of Political, Administrative and Communication Sciences, Babeș-Bolyai University, Cluj-Napoca, Romania
Gemma A Williams
European Observatory on Health Systems and Policies, London, United Kingdom
Matthias Wismar
2 European Observatory on Health Systems and Policies, Brussels, Belgium

Research Article

Keywords: Health and care workforce, heat-health action plan, health security, comparison, Europe

Posted Date: November 9th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11635866/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: The authors declare no competing interests.

Abstract

Background. A majority of European countries have heat-health action plans in place or under development, yet the health and social sectors are poorly considered despite their high burden and key role for health system resilience and security.

Objectives. This research connects workforce policy and heat-health action policy, aiming to assess preparedness, protection and agency of health and care workers and identify gaps and capacities for implementation.

Methods. Qualitative comparative methodology and a country case study design were applied and a rapid assessment of eight European countries performed during August/September 2026. A semi-structed topic guide informed data collection, drawing on policy documents and other secondary sources.

Results. No country case study established a dedicated workforce-centred heat-health strategy nor do they have routine workforce-specific heat-health surveillance systems in place. Countries recognise health workers primarily as service providers, rather than as a workforce requiring protection. This approach shapes all areas of heat-health action. Preparedness of health workers shows limited strategic action but with some adaptations at the provider and individual level and in the education sector. Protection remains poorly addressed and equality, gender equality and migrant health workers are largely absent. Professional stakeholders and bottom-up emerging adaptations create capacities but agency is limited. Four interrelated priorities for advancing workforce heat-health policy can be identified: alignment of heat-health policy and occupational health law; workforce-specific surveillance and monitoring; stakeholder involvement and transsectoral governance; and a European Union strategy.

Conclusions. Workforce resilience and climate-health resilience must be addressed together to ensure health security.

1. Background

A majority of European countries have heat-health action plans (HHAPs) in place or under development [1] to strengthen responses to extreme heat, which has killed more than 200,000 people in the European region over the past four years [2, 3] and contributed to increased morbidity, infectious diseases, adverse birth outcomes, food insecurity and social inequalities. [4] Most countries have also improved data and monitoring, expanded access to cooling systems and shelters, and increased attention to protecting vulnerable groups. Despite these advances, the health and social care sectors remain insufficiently addressed in HHAPs. [5–7]

This represents a critical gap, as these sectors are not only essential to protecting populations from extreme heat but are themselves increasingly vulnerable to its effects. Health and care workers (hereafter ‘health workers’) are already working at or above their limits, as multiple crises threaten their physical health and mental wellbeing, as well as the quality and safety of the services they provide. [8–12] Their vulnerability to heat stress is likely to worsen as temperatures rise and demographic change contributes to an ageing workforce more vulnerable to extreme heat. [8, 13] The climate crisis [14, 15] and health and care workforce crisis (hereafter ‘workforce crisis’) [11, 13, 16, 17] are thus mutually reinforcing: ‘extreme heat increases demand for health services while simultaneously reducing the capacity of the workforce needed to deliver them’. [18]

Despite this interdependence, heat-health action and workforce resilience remain largely disconnected in policy and practice. One major challenge is the lack of actionable policies, mandatory guidelines and comprehensive strategies that systematically address both. [18] While HHAPs and policy debates do not fully ignore health workers, they primarily emphasise their roles as care providers and the need for education and training. [19] Health workers are not systematically recognised as a vulnerable group, nor is the workforce considered critical health system infrastructure in need of dedicated protection and preparedness. [18] This policy gap persists despite the availability of more comprehensive recommendations and operational guidance from the WHO [14] (Box 1) and European Union (EU) institutions. [1, 20–22]

Box 1. WHO Heat-Health Action Plans, guidance

The recent update of the WHO Regional Office for Europe [14] highlights occupational risk to health workers for a wide range of groups in different sectors. Particularly vulnerable are, for instance, those wearing personal protective equipment, or providing care in the community. The latter may face physical and mental health risks during home visits and outdoor activities because they are working under environmental and psychological stressors, experiencing dehydration, heat-related illnesses and emotional fatigue. Major conditions and recommendations for ‘building a heat-prepared and protected workforce’ are cited below. [14, Chap. 5.2]

‘Protecting the health workforce during extreme heat therefore requires measures that reduce exposure and strengthen overall protection [to] protect staff health, support workforce capacity and maintain continuity of care during periods of extreme heat:

- providing heat-appropriate personal protective equipment and cooling aids;
- ensuring regular hydration and rest breaks with access to cool areas;
- adjusting work schedules and applying work/rest cycles;
- enabling simple self-monitoring and awareness of heat stress symptoms;
- implementing buddy systems or briefing staff to identify emerging risks; and
- supporting heat acclimatization planning for staff who need time to adapt to working safely in high temperatures’. [14, p101]

The report also highlights the important role of health workers for national, reginal and local HHAP implementation. [14]

End of Box 1

Beyond these gaps in policy recognition and guidance, a further challenge lies in translating existing commitments into effective implementation. Efforts to bring HHAPs into practice remain limited, despite Europe's leading role in climate change mitigation policies and technologies, and mounting research evidence of the urgency of adaptation. [4, 5] Countries often lack the essential institutional capacities necessary for effective implementation, including trans- or cross-sectoral governance, coherent coordination and communication mechanisms, appropriate inclusion of all relevant professional groups in decision-making, and effective leadership structures. [23–27] The key challenge, therefore, is not simply a lack of evidence or policy recommendations, but lack of political will [3] to establish and institutionalise governance architectures capable of translating HHAPs and workforce policies into practice.

These implementation challenges are reinforced through a mismatch between the inherently transsectoral nature of climate change adaptation and the fragmented institutional structures governing health systems and workforce policies. According to the WHO, 'In most countries, occupational heat risk is regulated under occupational health and safety legislation that require employers to undertake a risk assessment based on local context and (inter)national standards, and to report on heat-related incidents'. [14] Meanwhile HHAPs surveillance, preparedness and adaptive measures are governed through diverse legal and institutional frameworks. [1, 5, 28–29] This fragmentation creates a risk that responsibility for protecting health workers falls between occupational-health, climate-adaptation and health-system governance structures, while their role in maintaining service delivery remains central to HHAP implementation.

Against this background, this rapid comparative assessment of eight selected European countries (Czechia, France, Germany, Italy, Portugal, Romania, Spain, and the United Kingdom with a focus on England) examines how heat-health action and workforce policies are connected, with particular attention to the governance arrangements and capacities needed for effective policymaking and implementation. We argue that climate health resilience and workforce resilience are interdependent and mutually reinforcing conditions of health security. Specifically, we assess whether and how the workforce is treated as an important population group requiring protection, as critical health system infrastructure that must be prepared for extreme heat, and as a stakeholder group with agency in heat-health governance [18] and leadership capacity for policy implementation. [26] By providing one of the first comparative assessments of workforce-centred heat-health action in Europe, this study aims to add new knowledge that may support policymakers in responding more effectively to key policy challenges of contemporary societies.

2. Methods

A qualitative comparative methodology [30] and a country case study design are applied, connecting two important but largely separated strands of contemporary health policy research and debate: the workforce crisis and health system resilience, [11, 18, 26, 27, 31] and climate change and HHAP research. [5, 8, 32] A rapid comparative assessment of workforce inclusion in heat-health action plans and an analysis of implementation capacities was performed in August/September 2026. The methodological approach draws on recent comparative workforce research examining Europe's emerging health security architecture [33] and is adapted to heat-health action.

2.1 Conceptualising workforce and heat-health action

Health systems and governance theories serve as framework. [33] Governance is understood as 'the systematic and patterned way in which decisions are made and implemented' [34] and as the glue connecting different sectors, stakeholders and dimensions of health policy and system. [27] Following from this argumentation, the roles and responsibilities of health workers must be assessed across all areas and on all levels of HHAPs. [18]

Three major roles can be distinguished: health workers as critical infrastructure capacity ensuring the provision of care and health security, that must be better prepared for emerging demands; as a population requiring protection, suffering in the same way as the general population from the heat, but facing additional physical and mental burdens from increased workload and working hours; and as stakeholders and individual actors with agency in heat-health governance, capable of adapting and transforming healthcare that is fit for purpose, particularly under conditions of uncertainty. [18] Recognising the workforce as an active agent of policy adaptation and transformation [20, 29, 35, 36] alongside emerging bottom-up pressures and capacities [37] 'provides a more complete understanding of the workforce not only as a resource requiring protection, but as a central actor in crisis preparedness and resilience within the emerging EU security landscape'. [38]

2.2 Country sample, data collection and analysis

The study examines eight selected European countries alongside key EU and WHO policy approaches, drawing on a research team with expertise in workforce policy and HHAPs across national, European and global contexts. The country case sample includes the European Union (EU) member states Czechia, France, Germany, Italy, Portugal, Romania, and Spain, alongside the United Kingdom (UK) with a focus on England. This selection considers diversity in geographical and climatic conditions, health systems and centralised or decentralised governance architectures, [39–42] workforce indicators, [43, 44] and different stages of HHAPs' development. [45–52]

Six countries have established HHAPs at national, regional or both levels, while Romania is at an advanced stage of agreeing on a national HHAP and Czechia has a local plan in Prague. The selection also reflects diverse areas of expertise, enabling identification and synthesis of capacities for actionable heat-health policies and context-sensitive implementation strategies. Southern European countries are most strongly affected by extreme heat threats and have thus developed more complex responses and expertise. Germany is an important international player in climate mitigation/protection policy with a federal governance architecture that complicates coordinated national heat-health action. England pioneered research on heat-health impact following the strong 2003 heat crisis and increasingly addresses the role of health workers [53]. Romania and Czechia represent Central Eastern European countries advancing towards more formalised heat health policies. Table 1 provides an overview of the major health system and workforce indicators (Table 1) and Table 2 introduces the results of the HHAP assessment (Table 2).

Table 1
Overview: health systems and health and care workforce profiles

Categories	Czechia	France	Germany	Italy	Portugal	Romania	Spain	England/
Health system								
Governance	SHI with strong state regulation; partly decentralised	SHI with strong state regulation & Regional Health Agencies; decentralised	SHI with joint self-governance; decentralised, federalist	NHS/SSN national governance with high regional autonomy; decentralised	NHS/SNS state regulation; partly decentralised	SHI with some state regulation; partly decentralised	NHS/SNS with state regulation & Autonomous Regions; decentralised	NHS with regulatio centralis an eleme decentra
Finance	Mainly SHI employer–employee contributions & taxes, low OOP	Mainly SHI contributions & taxes, some private insurance, low OOP	Mainly SHI employer–employee contributions, some private insurance, some taxes, low OOP	Mainly taxes, relevant OOP	Mainly taxes with some voluntary private insurance & high OOP	Mainly SHI employer–employee contributions with large groups exempted from SHI & OOP	Mainly taxes, some OOP	Mainly ta low OOP
Total health expenditure, % GDP[#]	8.5	11.5	12.3	8.4	10.2	5.7	9.2	11.1
Provision & UHC Service Coverage Index[Φ]	SHI & private providers; hospital-centred, no gatekeeping, private office-based PHC & specialists care, UHC Index: 83	Mixed public–private provision, hospital-centred, mainly office-based PHC, weak gatekeeping, UHC Index: 82	Mixed public-private provision, hospital centred, mainly office-based PHC, weak gatekeeping, UHC Index: 86	Mixed public-private provision, hospital-centred, PHC & gatekeeping, UHC Index: 82	NHS/public hospitals, PHC-centred with relevant private provision & gatekeeping, UHC Index: 84	SHI & private provision, hospital-centred with weak PHC & community care, weak gatekeeping, urban-rural gap, UHC Index: 71	Mainly public provision, with strong PHC & gatekeeping, specialist & hospital care through referral, UHC Index: 84	NHS pub some pri mix, stro PHC, gatekeep UHC Inde
Health and care workforce								
HCWF strategy	No coherent strategy; national by MoH with centralised data-driven planning, monitoring & education	No single strategy, national policies	No coherent strategy, decentralised with fragmented national, regional & professional responsibilities	No comprehensive strategy, national frameworks with regional planning & management	Broader national HCWF planning, centralised by MoH & NHS administration	National strategy, centralised by MoH with fragmented regional implementation	No single strategy, national by MoH planning with Autonomous Communities & profession-specific plans	National term stra part of b NHS refo
HCWF governance & multilevel action	No formal HCWF-specific structures; hierarchical with some professional interaction	National governance with decentralisation; multi-level transsectoral infrastructure & strong role of professional bodies	No coherent HCWF-specific structures; federalist with regional-national fragmentation, weak sectoral & professional connections	NHS national framework with decentralisation; multilevel formalised coordination	NHS hierarchical administration centred on professions; some sectoral & professions connections but no national platform	SHI governance, hierarchical, centralised with moderate to poor national-regional level coordination	SNS multilevel decentralised with national level & Autonomous Communities coordinated through SNS bodies	NHS hierarchi governar decentra multileve transsect coordina
Health & social work employment*	7.72	14.98	15.25	8.96	8.84	5.54	8.2	13.52

Source: authors' own table, based on public statistics, HSPMs or related reports, and expert information

[] OECD data and WHO UHC service coverage index refer to the UK, other items to England.

[#] OECD, 2024 or nearest year.

[Φ] WHO, 2024.

* OECD, 2025 or nearest year, retrieved 26 August 2026; for information on sources and methods, see OECD, 2025.

• Health & social work employment refers to percent total civilian employment.

• Workforce data refer to per 1,000 population head counts; practising physicians; nurses and nursing associates practising, for Portugal: 'licensed physician 'professionally active nurses'.

• Gender ratio refers to women, percent of the profession.

• Migrants refer to foreign-trained physicians and nurses, percent of the profession.

Categories	Czechia	France	Germany	Italy	Portugal	Romania	Spain	England/
Hospital employment density*	18.82	20.39	18.98	11.94	n/a	10.72	14.52	24.18
Physician density*	4.29	3.94	4.75	5.75	4.31	3.81	4.64	3.49
- gender ratio, %*	58	51	50	48	65	70	48	51
- migrants, %*	9	11	16	1	n/a	2	n/a	40
Nurse density*	9.09	n/a	12.51	6.92	7.21	8.38	5.73	9.29
- gender ratio, %*	97	87	83	76	n/a	91	84	88
- migrant, %s*	0	3	11	5	n/a	0	n/a	25
Source: authors' own table, based on public statistics, HSPMs or related reports, and expert information								
[] OECD data and WHO UHC service coverage index refer to the UK, other items to England.								
# OECD, 2024 or nearest year.								
Φ WHO, 2024.								
* OECD, 2025 or nearest year, retrieved 26 August 2026; for information on sources and methods, see OECD, 2025.								
• Health & social work employment refers to percent total civilian employment.								
• Workforce data refer to per 1,000 population head counts; practising physicians; nurses and nursing associates practising, for Portugal: 'licensed physician 'professionally active nurses'.								
• Gender ratio refers to women, percent of the profession.								
• Migrants refer to foreign-trained physicians and nurses, percent of the profession.								

Table 2

Overview: Heat-Health Action Plans[Ø]

Heat-Health Action Plans (HHAPs)[Ø], eight core elements defined by WHO, 2026								
Overview	No national HHAP, partly covered by government & local strategies; Prague has a regional HHAP	Dedicated national HHAP, implemented annually; national HHAP since 2004	No national HHAP but guidelines for federal states & local authorities; some HHAPs on both levels	Dedicated national HHAP; national HHAP since 2005	Dedicated, national HHAP; HHAP since 2004	No national HHAP, but covered by government strategic actions; some local HHAPs	Dedicated national HHAP adopted in April 2026; national HHAP since 2004	Dedi natic natic since
Governance	Not nationally defined	National governance, strong multilevel transsectoral coordination	Decentralised, federalist, network-based, weak coordination	National governance, formalised & funded coordination	National governance, legally mandated coordination	Not nationally defined	National governance, strong multilevel transsectoral coordination	Natic gove stror mult trans coor
Heat-health warning systems	Limited, meteorological warnings only	Comprehensive, localised graded alerts	Comprehensive, localised national warnings	Comprehensive, city-specific graded alerts	Partly, threshold details incomplete	Limited, weather alerts only	Comprehensive, localised graded alerts	Com impa grad
Populations at increased risk	Partly. Key groups identified	Comprehensive, registered vulnerable residents	Limited, fragmented sub-national examples	Comprehensive, broad risk coverage	Comprehensive, identified groups plus outreach	Limited, few groups identified	Comprehensive, broad risk coverage	Com equit risk
Communication	Partly, general strategy messaging	Comprehensive, graded multichannel communication	Partly, nation-wide alert communication	Comprehensive, graded seasonal communication	Comprehensive, tailored multichannel communication	Limited, ad hoc public advice	Comprehensive, targeted tiered messaging	Com targe mes
Health system resilience	Absent, not nationally defined	Comprehensive, sector-specific facility plans	Limited, fragmented sub-national examples	Comprehensive, level-specific facility preparedness	Comprehensive, graded system preparedness	Limited, ad hoc surge measures	Limited, professional roles only	Com secto prep
Reducing heat exposure	Partly, focus on urban adaptation	Comprehensive, multilevel exposure reduction	Limited, fragmented sub-national examples	Comprehensive, urban/ building adaptation	Partly, municipal measures predominate	Absent, not nationally defined	Limited, individual advice only	Com beha plus
Heat-health surveillance	Limited, proposed indicators only	Party, mortality data delayed	Partly, weekly report on heat-related mortality	Comprehensive, near-real-time surveillance	Comprehensive, continuous integrated surveillance	Absent, not nationally defined	Comprehensive, daily mortality surveillance	Com mort dem mon
Monitoring, evaluation and learning	Absent, not nationally defined	Comprehensive, institutionalised annual learning	Limited, fragmented sub-national examples	Partly, post-season review established	Comprehensive, formal learning cycle	Absent, not nationally defined	Comprehensive, routine seasonal evaluation	Com comp evalu fram

Source: authors' own table, based on HHAP documents

[Ø] Heat-Health Action Plan (HHAP) serves as an umbrella and common terminology across the country cases, including the typical form of institutionalised r action plans, as well as national-level guidelines and regional/federalist action plans.

[§] Assessment scale for HHAPs. Comprehensive: comprehensive and operational coverage. Partly: important elements present, with gaps. Limited: narrow, a incomplete coverage. Absent: not defined at national level. Please note, 'comprehensive' does not imply that existing policy plans will turn into effective acti of emergency.

---------- Insert Table 1 about here ----------

A semi-structured topic guide was developed, considering national and global approaches and focusing on workforce indicators. It combines questionnaire-like standardised items with qualitative-explorative semi-standardised questions and freetext responses where relevant (Supplementary material Table S0). The standardised items provide a descriptive comparative overview and facilitate cross-country comparison, while the semi-standardised qualitative data add more depth and enable explorative analysis. The HHAP overview (Table 2) draws on eight core elements as defined in the updated WHO Framework for Heat-Health Action: governance; heat–health warning systems; populations at increased risk; communication; health system resilience; reducing heat exposure; heat–health surveillance; and monitoring, evaluation and learning. [14] The workforce dimension is operationalised through a more complex analytical matrix based on four broad thematic categories: governance and policy, preparedness, protection, and agency and capacities of the workforce (Table 3–Table 6).

Table 3
Heat-health workforce policy and governance in selected EU countries

Categories	Czechia	France	Germany	Italy	Portugal	Romania	Spain	Englar
Policy & governance								
Inclusion of HCWF in HHAP	No. No national HHAP exists but for Prague; it does not include HCWs.	Partly. Strong as providers, but hardly as critical group to be protected.	Partly. As policy stakeholders & providers, but hardly as critical group to be protected.	Partly. As policy implementers & providers, but to a lesser extent as workforce to be protected.	Partly. As providers including training, but hardly as an at-risk workforce.	Partly. As providers & operational resource, but hardly as an at-risk workforce.	Partly. As policy implementers & providers, but hardly as an at-risk workforce.	Partly. as sys capac increa HCWs as vul popul
Dedicated heat-health HCWF strategy	No.	No. Broader protection through occupational-health regulation.	No. Broader occupational & climate-health governance.	No. Broader occupational & climate-health governance exist.	No. Local & provider-level efforts may exis.t	No.	No. Broader occupational & climate-health governance exist.	No. Re measu but ar scatte
Inclusion of climate/heat in HCWF planning	No.	Partly. For operational/ surge planning, but not for long-term HCWF forecasting.	No.	No.	No.	No.	Partly. Operationally, yes, but not in strategic workforce planning.	Partly. Operat 'yes', b strate workfo foreca
Multi-level, transsectoral governance	Partly. Some transsectoral structures on national & Prague level, but limited.	Yes. Strong, but connection to HCW protection is partly indirect.	Yes. But variety across levels including bottom-up & not systematically coordinated.	Partly. Inter-governmental group under MoH leadership.	Yes. HHAP links national-regional level health & civil protection, but no dedicated HCWF linkage.	Partly. Some strategic commitment, but no operating structure.	Yes. Strong; weaker for HCWF but inter-governmental group.	Yes. S infrast but int of HC remai incom
Inclusion of professional associations	No.	Partly. Strong implementation role, but limited institutionalised representation.	Yes. Major professional associations are part of HHAP governance.	Partly. No formal role nationally, but regionally & in occupational protection policy.	No.	No.	Partly. Expertise & guidance with limited formal inclusion, but collaboration on national service protocols.	Partly. Stakeh contri NHS w strong impler role.
Inclusion of HCWF in policy debate	No.	Partly. Different approaches; HHAP: HCWF as healthcare response capacity; Labour Code: workers requiring heat protection.	Partly. Focus on provider role/ patient care, but some attention to education & organisational adaptation (working plans, cooling systems, etc.).	Partly. As providers & at-risk group, but focused on individuals & vulnerabilities.	Partly. Nursing union connects climate change to pressures on health services & nursing.	Partly. Focus is on provider role/ patient care.	Partly. Focus on patient care/ vulnerable groups, but OSCC group may create a bridge between heat-health & occupational health.	Yes. H impler & resp capac as wo be pre empo health resilie
Inclusion of HCWF in media debate	Partly. HCWs are mentioned, but focus is on provider role & hospitals.	Partly. There is increasing attention, but not a dominant framing.	Partly. During heat waves some attention to high burden, but limited.	Partly. Media focuses on provider role, unions & professions on HCW workplace stress.	Partly. Some examples exist, but no campaign.	Partly. Examples exist, but no campaign but.	Yes. Focus on temperature & work conditions; nurses connect thermal stress with HCW health & quality of care.	Yes. Subst attenti highli pressu NHS, H and pa safety
HCWF specific heat-health information	Partly. General information through occupational health, but missing in Prague HHAP.	Yes. Mostly limited to the provider role & patient protection.	Partly. Mostly limited to the provider role & patient protection.	Yes. Mostly limited to the provider role, but general information on occupational protection.	Partly. Through national law, focusing risk communication.	No. General heat-period recommendations mention occupation-specific vulnerable factors.	Yes. Mostly focused on the provider role & patient protection.	Yes. T with a patien some dedica HCWF guidar

Sources: authors' own table, based on expert country case study material, supplementary material Table S1-Table S8.

Categories	Czechia	France	Germany	Italy	Portugal	Romania	Spain	Englar
Surveillance & research								
Surveillance of HCWF during heat waves	No. General workplace-heat exposure monitoring exists.	No.	No. Some guidelines exist & EU-89/391/EWG, occupational protection, applies.	No. General measures exist.	No. General monitoring of mortality exists.	No. General measures exist.	No. General workplace-heat exposure surveillance exists.	No. Pr level e may e
Impact of climate disasters/heat on HCWF	No. General data exist.	Partly. Heat-health & healthcare-demand data, but weak HCWF-specific outcome data.	Partly. Survey data show increased workload; correlation of admissions & sickness leaves.	Partly. Extensive general data exist, but not targeting HCWF.	No.	No.	Partly. Extensive general data exist, but not targeting HCWF.	Partly. qualita eviden no out datase
Monitoring of heat-related HCWF sickness	No.	Partly. Through occupational-health mechanisms.	No.	No.	No.	No.	No.	Partly. routine survei but wo risk asses
Research evidence	No. Available evidence addresses population health.	Partly. Very limited; a large survey shows knowledge gaps & demand for organisational action.	Partly. Some ad-hoc survey data collected by SHI stakeholders & Union, but overall poor.	Partly. Limited to scattered survey data.	Partly. Limited to some qualitative data.	No.	Partly. Focus is on population & competencies, not HCWF exposure.	Yes. R survey exist, l eviden remain limited
Research programs	No. A broader heat-health warning-system exists.	Partly. National survey on physicians, nurses, pharmacists, etc. is ongoing.	Partly. Some efforts in progress, but funding is unclear.	Partly. Broader programs exist, but do not target HCWF.	No.	No. A National Observatory for Climate&Health in progress could provide an institutional mechanism.	Yes. The OSCC working group provides institutional mechanisms.	Yes. H includ capac buildir infrast exists, limited

Sources: authors' own table, based on expert country case study material, supplementary material Table S1-Table S8.

---------- Insert Table 2 about here ----------

Data were collected in August/September 226 by national and EU-level experts using public statistics, policy documents, official websites and grey literature (for detailed national references, see supplementary material, Table S1–S8). Each country case was reviewed by a lead author and one of the HHAP experts in the team. Comments and queries were discussed with the individual authors until consensus was achieved and revised version were subsequently prepared and agreed. These country case forms (supplementary material, Tables S1–S8) provide the basis of our comparative analysis and contain detailed country-specific references omitted from the main text. Using thematic analysis and a combined deductive-inductive coding approach, the lead author conducted a comparative analysis drawing on input from HHAP and global experts and the wider research team. Findings were discussed iteratively until consensus was reached.

3. Results

3.1 Governance and policy of workforce heat-health action

Governance arrangements significantly shape the way countries develop and implement workforce heat-health measures. Our selection of countries considers centralised, decentralised and mixed approaches across health systems, workforce policies and HHAPs (Table 1, Table 2). However, despite these different institutional arrangements none of the countries has a dedicated workforce-centred heat-health strategy (Table 3). This includes France, Italy, Portugal and England, despite their comprehensive health system resilience measures and France, Portugal, Spain and England despite their strong multi-level, transsectoral governance arrangements. France, Spain and England partly have included climate related disasters in their operational workforce planning, but strategic planning and forecasting remain absent across all eight countries.

With the exception of Czechia, where no national HHAP exists, countries recognise health workers primarily as service providers, rather than as a workforce requiring protection. This approach shapes the policy debate, media coverage and workforce specific heat-health information, although England shows comparatively greater recognition of occupational risks in those three areas. Health workers are rarely recognised as active stakeholders whose practical experience and competencies could inform the development and implementation of heat-health policy. Formal professional representation in HHAP governance is absent or limited in Czechia, France, Italy, Portugal, Romania, Spain and England, with Germany providing a notable exception.

---------- Insert Table 3 about here ----------

These shortcomings extend to surveillance, monitoring and research. None of the eight countries has established routine workforce-specific heat health surveillance, including France, Italy, Spain and England, despite their more comprehensive population-level surveillance systems (Table 2). France, Germany, Italy, Spain and England have some data on heat-related workforce impacts, while France and England also monitor relevant occupational outcomes through existing mechanisms without systematic national workforce surveillance (Table 3). Overall, research is very limited across the countries included in our sample, often focused on qualitative data or small surveys and scattered, although England has comparatively more developed research capacities. France, Germany, Italy, Spain and England have initiated efforts to strengthen the evidence base, particularly through research programmes or institutional mechanisms in Spain and England. Romania is developing a national climate-health observatory, while Czechia and Portugal show limited progress towards dedicated workforce research infrastructure.

3.2 Preparedness of health workers

Preparedness matters at three levels: organisation and provider level measures, education and training capacities, and individual health worker capacities (Table 4). Some organisational adaptations, including cooling facilities, ventilation and adjustments to working conditions, exist to varying degrees in all countries. However, implementation remains uneven, infrastructure resilience is limited, and measures are frequently insufficiently specified in HHAPs. Dedicated financial support is largely absent, although Germany and England provide limited opportunities through broader infrastructure investment programmes. Working-time adjustments are addressed through occupational-health frameworks across all eight countries, most systematically in France. However, fragmented responsibilities between occupational protection and healthcare delivery create implementation gaps and potentially conflicting priorities.

Table 4
Preparedness of health workers in selected EU countries

Categories	Czechia	France	Germany	Italy	Portugal	Romania	Spain	England
Preparedness, organisation								
Workplaces & infrastructures	Partly. Cooling measures exit, availability varies between providers.	Partly. Strong regulatory & planning capacity, but uneven physical infrastructure.	Partly. Uneven between sectors, providers, units; guidelines exist, but limited implementation.	Partly. Recommendations at national, regional & local level, but lack of implementation strategy.	Partly. Limited; HHAP focuses on cooling, implementation is unclear.	Partly. Not addressed in HHAP, decided at facility-level & unevenly across facilities.	Partly. HHAP focuses on population health, but sub-national efforts may exist.	Partly. S prepare measur deficier infrastr resilien
Support and compensation for investment	No.	No.	Partly. Through infrastructure investment, but limited & competitive.	No. Local-regional efforts may exist.	No.	No.	No. Sub-national efforts may exist.	Partly. T broader investm no dedi progran
Adaptation of working plans & hours	Partly. Limited to general occupational health protection guidance.	Yes. Through complex occupational-health regulation.	Partly. Complex guidelines exist, but limited implementation.	Partly. Through general occupational heat-protection policies, but limited local & scattered implementation.	Partly. Through occupational guidelines on HCW protection & HHAP on provision; targets may be conflicting.	Partly. No HHAP guidance but through general worker protection; targets may conflict with MoH measures.	Partly. General worker protection exists, but operational standards are weak for HCWs.	Partly. (exampl but no u HCW he working regime.
Education								
Strategic investment	Partly. Pilot e-learning project in Prague, but no strategy.	Partly. Increasingly incorporated, but poor national inclusion.	No. Some efforts on local & provider level.	Partly. No strategy, but broader national training & funding programs exist.	Partly. HHAP specifies continuous capacity building, but no strategy exists.	No.	Partly. No strategy, but infrastructure & OSCC mandate to promote education.	Partly. N strategy recomm & meas
Inclusion of climate/heat in education	Partly. Limited to provider level, no strategy.	Partly. Training initiatives with universities & providers, but no strategy.	Partly. Several efforts on professions & provider level.	Yes. National program & recommendations on specialisation.	Partly. Very limited; provider-level example exists.	No. Provider-level examples might exist.	Partly. Increasingly present, but uneven & not mandatory.	Partly. Increas present uneven standar
Inclusion of heat-health skills in curricula	Partly. Very limited to a few medical issues.	Partly. Clinical guidance & professional materials, but no curricular integration.	No. Examples might exist locally.	Partly. Limited to inclusion in broader climate change education.	Partly. Limited to more general inclusion in clinical education.	Partly. Limited to more general inclusion in clinical education..	Partly. Addressed through HHAP professional protocols & clinical guidance.	Partly. L some profess
Master-level courses	No.	No.	No. Provider efforts may exist & international material.	Partly. Provider-level examples, but no broader inclusion exist.	No.	No. Examples might exist at provider level.	Partly. Relevant programs exist, but no broader inclusion.	No. Reg provide exampl exist.
HCWs, individual level								
Policy measures	Partly. National occupational health guidance identifies HCWs as at-risk group & provides guidelines.	Yes. Strong focus on patient care & much weaker on HCWs own exposure.	Yes. Guidelines exist for several HCWs but focus on patient care; implementation is not monitored.	Partly. Strong focus on patient care & limited to education.	Partly. HHAP specifies training exercises & webinars.	Partly. Focus is on patient care & much weaker on HCWs own exposure.	Yes. Strong focus on patient care & much weaker on HCWs own exposure.	Yes. HH profess measur strong f patient

Source: authors' own table, based on expert country case study material, supplementary material Table S1-Table S8

Categories	Czechia	France	Germany	Italy	Portugal	Romania	Spain	Englanc
Competency development	Partly. Courses are available, but no systematic support.	Partly. Guidance, legal mandate & training resources exist, but no specific incentives.	Partly. HHAP recommends integration in nursing & medical education, but action is unclear	Partly. Limited to training options & provider role; no competency framework.	Partly. Limited to training options.	No. Continuing education exists for physicians through which competencies could be incentivised.	Partly. Professional guidance exists & OSCC promotes specialised climate-health education.	Partly. I training no evalı compet framew
Information on perceptions of HCWs	No.	Partly. For climate health, but less specifically for heat.	Partly. Complex manuals from professional organisations, but focus is on patient care.	No. Broader information on climate change reveals knowledge gaps.	Partly. Limited, qualitative study shows training gaps.	No.	No.	Partly. I dated e

Source: authors' own table, based on expert country case study material, supplementary material Table S1-Table S8

Strategic investment in heat-health education remains limited. Czechia, France, Italy, Portugal, Spain and England report educational initiatives, while Germany primarily relies on local or provider-level activities and Romania lacks an identifiable strategy. Italy stands out for its national climate-health training programme. Elsewhere, training is predominantly organised locally or through individual providers. Heat-health competencies are generally embedded within broader climate-health education, clinical guidance or professional protocols rather than dedicated curricula. Spain explicitly addresses professional protocols within its HHAP, while specialised master's-level provision remains limited to isolated examples in Italy and Spain.

---------- Insert Table 4 about here ----------

At the individual level, all eight countries provide varying degrees of guidance for preparing health workers to respond to extreme heat. However, these measures predominantly emphasise patient care, particularly for vulnerable populations, rather than workers' own exposure. Occupational-health regulations provide additional protection, but workforce-specific competency development remains fragmented. France combines guidance with legal obligations, while Spain promotes specialised climate-health education through emerging institutional structures. Germany recommends integrating heat-health competencies into professional education, although implementation remains uncertain. Across all eight countries, systematic competency frameworks and evidence on health workers' preparedness, perceptions and training needs remain limited. It is also unclear how health workers themselves perceive training needs and preparedness measures, but existing information reveals knowledge gaps.

3.3 Protection of health workers

Workforce protection is the most neglected dimension of heat-health action (Table 5), despite comprehensive identification of vulnerable populations in the HHAPs of France, Italy, Portugal, Spain and England (Table 2). Most countries provide some guidance on physical protection, with Romania and Spain as an exception, and England offering the most explicit health and social care workforce provisions. Romania lacks dedicated workforce-specific measures. Mental health and psychosocial support receive even less attention: only France and England include limited provisions, focused respectively on hospital crisis management and professional support recommendations. Protection of vulnerable groups of health workers is only included in the English HHAP, while gender equality and the situation of migrant health workers remain unaddressed across all eight countries.

Table 5
Protection of health workers in selected EU countries

Categories	Czechia	France	Germany	Italy	Portugal	Romania	Spain	England/UK
Protection of HCWF								
HHAP guidelines on physical protection	Partly. National occupational health guidance identifies HCWs as at-risk group & provides measures.	Partly. HHAP recognises but fails to specify HCW protection; occupational law provides stronger protection.	Partly. Health protection law applies & some guidelines exist, but not mandatory.	Partly. HHAP recognises but fails to specify HCW protection; broader worker protection does not specify HCWs.	Partly. HHAP fails; occupational law provides guidance on HCW exposure reduction & protection.	No. HHAP does not define protection & occupational law is not HCWF-specific.	No. HHAP fails to specify general occupational protection for HCWs, but employer & regional policy may exist.	Yes. For HCWs & social care professionals.
HHAP guidelines on mental health & social support	No.	Partly. Hospital guidelines define support for HCWs managing crises.	No. Efforts may exist locally, e.g. helplines.	No. Broader efforts for population health might apply.	No.	No.	No.	Partly. Limited to recommendations for HCWs.
Vulnerable groups	No. General protection of vulnerable groups applies.	No. General occupational protection law applies.	No. General occupational protection law applies.	No. General occupational protection law applies.	No. General occupational protection exists for pregnant women, older people & NCDs.	No. General occupational law applies.	No. Addressed for population health, but not HCWs.	Partly. Limited to recommendations for HCWs.
Gender equality	No.	No.	No.	No.	No.	No.	No. Addressed for population health, but not HCWs.	No. Addressed for population health, but not HCWs.
HCW migrants	No.	No.	No.	No.	No.	No.	No.	No.
Information on HCW perceptions	No.	No. But a planned national consultation will likely improve information.	Partly. Survey data highlight improved heat protection & weak linkage with HCWF shortages.	Partly. Very limited; a few examples exist.	No.	No.	Partly. Some local evidence on high burden through union & professional statements.	Partly. Limited to local examples.

Source: authors' own table, based on expert country case study material, supplementary material Table S1-Table S8.

Evidence on health workers' perceptions of occupational heat exposure is similarly scarce. Available information includes local studies or initiatives in Italy, Spain and England, and small surveys in Germany. France is planning a national consultation. Although unions and media occasionally connect heat exposure with staffing shortages and excessive workloads, these relationships remain poorly integrated into formal workforce protection policies (Table 3).

---------- Insert Table 5 about here ----------

3.4 Agency and capacities of health workers

On the national level, all countries except Romania have some recommendations in place to strengthen preparedness and protection of health workers (Table 6). However, implementation is constrained by fragmented responsibilities between HHAPs and occupational-health frameworks, alongside a persistent emphasis on preparing health workers to deliver care rather than protecting their own health.

Table 6
Stakeholder agency and capacities in selected European countries

Categories	Czechia	France	Germany	Italy	Portugal	Romania	Spain
Agency & capacities							
Policy statements of professions & unions	No. The Nursing Association provides a translation of a European statement.	Yes. For climate-health/ environmental action more broadly & partly for heat-specific HCWF protection.	Yes. Manuals for physicians & nurses but strong focus on provider role; Union links heat impact to low staffing levels.	Yes. Unions & professions highlight pressure & links to LTC; nurses demand structural plans for prevention.	Partly. E.g. Nursing union links climate change to HCW pressures; heat-specific staffing & cooling concerns.	No.	Yes. Health sector & nursing union demand stronger workplace heat protection.
Recommendation for preparedness & protection	Yes. National recommendations on heat exposure & measures, e.g., cooling, breaks, work planning, PPE adaptation, attention to vulnerable HCWs.	Yes. But fragmented, health policy is preparing HCWs to protect patients, occupational policy is protecting HCWs as workers.	Yes. Some inclusion in HHAP & sector/ profession-specific for GPs, hospitals, nursing homes, home care, pharmacies, psychotherapy offices.	Yes. But fragmented responsibilities; HHAP focuses on provider role, occupational policies target worker protection but do not specify HCWs.	Partly. Medical Emergency Service provides national recommendations.	No. General heat-health recommendations refer to occupational exposure as a vulnerability factor, but no HCW-specific information.	Yes. But stronger for preparedness than protection; fragmented responsibilitie of HHAP for patient care, unions for HCW protection.
Bottom-up developed adaptations, self-efficacy	No. Individual examples exist, but no HCWF-led initiatives.	Partly. E.g., SOS Médecins France network of private physicians plays a role as shock absorber, but is strongly focused on patient care.	Partly. Examples exist, e.g. universities develop courses & public health actors transsectoral structures, but no systematic coordination.	Partly. Some examples exist on organisation-led action & union action at local level, but no systematic integration.	No.	Partly. Some ad-hoc facility-level, bottom-up adaptation, but not systematically integrated in HHAP.	Partly. Overall poor and focused on patients; ad-hoc frontline action, but no systematicall integrated in HHAP.
Professional networks on heat-health	No. Broader climate-health initiatives exist.	No. Overlaps may exist, as a physician networking culture exists that might include heat-health action.	Yes. Several multi-professional transsectoral provider networks; MoH suggests local Heat Protection Alliances.	No. Broader climate change-related examples exist.	No. More general examples exist for One Health.	No.	Partly. No single heat-specific but overlapping networks; OSCC platfor is designed to create multisectoral spaces.

Source: authors' own table, based on expert country case study material, supplementary material Table S1-Table S8

Professional groups and unions are important stakeholder groups in the heat-health debate. Efforts are strongest in France, Germany, Italy, Spain and England and largely absent in Czechia and Romania. Key demands include stronger occupational protection, improved working conditions and structural preparedness measures. Nursing organisations in Germany, Italy, Portugal, Spain and England have highlighted the interaction between extreme heat, staffing pressures and workforce wellbeing, while Italian unions remind about the specific vulnerabilities of long-term and residential care workers.

---------- Insert Table 6 about here ----------

Bottom-up adaptations were identified in France, Germany, Italy, Romania, Spain and England, but not as established workforce-led initiatives in Czechia and Portugal. These initiatives highlight strong problem-solving capacities, although activities predominantly focus on maintaining service delivery. Interesting examples include GP-led adaptations in England that had an impact on service provision, a network of private physicians in France acting as 'shock absorber' during crises, and multi-professional university courses and transsectoral structures developed by public health actors in Germany. Multidisciplinary heat-health networks exist in Germany, Italy and England, while Spain has overlapping professional networks and an emerging institutional platform. However, we could not identify examples of systematic integration of bottom-up driven health-health action into HHAPs. Spain's climate-health observatory and Germany's proposed local Heat Protection Alliances offer potential mechanisms for strengthening these connections.

4. Discussion

Our research reveals a strong gap in European HHAPs, which insufficiently considers the key role of health workers in maintaining health systems resilience and service provision during extreme heat, with England showing a more positive trend. [53] The novelty of the topic and limited systematic evidence constrain the opportunity to discuss the results in a broader context, but available studies and policy assessments largely support our findings [2, 3, 8, 54]

and the core role of the workforce during crises. [33, 55–57] The most pronounced policy gap is workforce protection. [9, 58] Especially mental health and psychosocial support measures as well as attention to equity related vulnerabilities associated with gender, ethnicity, and specific health needs are largely absent. These omissions persist despite mounting evidence of occupational risk and recommendations for action. [12, 16, 57, 59–60]

Important gaps also exist in operational governance, particularly in measures aimed at strengthening workforce preparedness. We identified some initiatives, at organisational and professional levels, consistent with the growing attention to education and training efforts as highlighted in the literature. [19, 20, 61, 62] However, a systematic approach and coordination measures were missing on all levels, including sustainable financing arrangements and dedicated leadership capacities. [5, 24]

Notably, our comparative findings reveal no consistent relationship between HHAP characteristics, health system governance arrangements, workforce governance approaches, and or the development of workforce heat-health measures. This may be an indication of underlying structural weaknesses that hamper systematic coordination of workforce-centred heat-health measures and create gaps in policy implementation. Stronger workforce protection and preparedness for extreme heat, therefore, do not necessarily coincide with more comprehensive HHAPs, established transsectoral governance arrangements or broader provisions for vulnerable populations, resilience, surveillance and heat-exposure reduction. This suggests that general progress in heat-health governance does not automatically translate into workforce-specific action. This makes it difficult to specify supportive environments and institutional capabilities for effective heat-health workforce policy, but some interesting similarities and capacities for action are emerging from the comparative results. Four interrelated priorities for advancing workforce heat-health policy can be identified.

First, strengthening legal and institutional alignment between HHAPs and occupational health and safety frameworks is a key measure for improving workforce protection and preparedness. Currently, these policy areas operate largely through separate regulatory and governance arrangements, creating fragmented responsibilities and potential implementation gaps. Greater alignment would help establish clearer institutional mandates, define responsibilities across national, regional and organisational levels, and ensure that workforce protection becomes an explicit component of heat-health preparedness rather than remaining primarily an employer-level occupational health obligation. This requires integrating workforce-specific measures into HHAPs while connecting them to existing occupational protection requirements, health system planning and organisational preparedness.

Second, stronger institutional alignment would allow for the systematic integration of workforce-specific indicators into existing HHAPs surveillance and occupational health monitoring systems. This would improve the availability and comparability of data on occupational heat exposure, heat-related illness, sickness absence, working conditions and workforce capacity during extreme heat events, and finally provide indicators for monitoring the implementation capacity and outcome of workforce-related heat-health action. Particular attention should be given to vulnerable workforce groups and equity considerations, including gender-sensitive indicators and age-disaggregated data to better understand the needs of older health workers, whose share of the workforce is rapidly growing across many countries and professions. [8, 13]

Migrants and refugees are a further relevant group that remains largely absent from workforce heat-health surveillance and policy, even in countries with a high proportion of migrant workers (Table 1). Their exposure may be compounded by concentration in lower-paid or less protected occupations and care settings, including nursing homes and home care services, where cooling infrastructure may be inadequate and work may involve travel or outdoor exposure. [63] More comprehensive and disaggregated workforce data would support targeted protection measures, identify inequalities and strengthen the evidence base for workforce planning and preparedness.

Third, a more systematic involvement of a wider range of workforce stakeholders and stronger attention to bottom-up capacities could strengthen both the design and implementation of workforce heat-health policies. Broader participation of professional associations, unions and frontline workers would help integrate practical experience, locally developed solutions and workforce specific needs. [37, 38] Our findings suggest that professional organisations and frontline workers can develop innovative responses to heat-related challenges, particularly where institutional guidance remains limited [58, 64] (for details, see S1–S8). However, these capacities remain fragmented and insufficiently mobilised because existing transsectoral governance and coordination arrangements rarely provide systematic mechanisms for incorporating workforce-led initiatives into policy development and implementation.

Workforce heat-health policy illustrates the core importance of governance, namely connecting policy objectives, institutional responsibilities and implementation capacities. [34] Effective responses require comprehensive transsectoral governance arrangements [23] that link climate adaptation, occupational protection, workforce planning and health service delivery. Such arrangements could also facilitate the use of co-benefit approaches [65] whereby investments in workforce protection and preparedness simultaneously strengthen service continuity, workforce wellbeing, retention and broader health system resilience.

Fourth, national level action to strengthen workforce-centred heat-health policies should be complemented by a more coherent European policy framework. While national and subnational action remains essential, a comprehensive EU workforce-centred heat-health strategy could strengthen policy coherence, facilitate cross-country learning and support more consistent implementation of existing WHO recommendations. [14] Developing an EU strategy can build on existing EU institutions, programs and research evidence in both the area of heat-health [1, 66] and workforce planning and skills development. [27, 67–69]

Better alignment of these policy frameworks, governance mechanisms and funding resources would provide a foundation for integrating workforce protection and preparedness into national HHAPs and broader health system resilience strategies. At the European level, this could facilitate common workforce indicators, shared competency frameworks and coordinated approaches to occupational protection, while allowing adaptation to national and local contexts. Europe's role in climate change policy could also help put health workers on the global agenda, improving their protection and preparedness in low-and middle-income countries and providing data, evidence and guidance for workforce-centred global climate change strategies.

4.1 Limitations

Several limitations must be acknowledged. First, our rapid assessment focuses on the identification of policy gaps in HHAPs and capacities for more effective workforce heat-health action, while the actual implementation of these policies is outside the scope of secondary sources and expert knowledge and would need comprehensive original data and qualitative research. It is important to keep in mind that climate change policy generally faces a strong implementation gap. Policy plans and capacities may therefore pave the way for action but do not automatically translate into practical improvements or effective responses during emergencies.

Second, the case studies assess HHAPs and primarily national-level action with some additional publicly available information on professional and provider-level efforts, but do not provide in-depth information on micro-level developments. Third, the country case selection considers diversity of European countries but draws on convenient sample that may have missed relevant institutional settings and policy approaches. Fourth, data collection relied on the expert author team and an unstructured review of policy documents and websites, which may not be comprehensive. Our results provide first evidence of capacities that may inform future more comprehensive primary research, deepen the analysis and specify implementation capacities and institutional capabilities.

5. Conclusions

This comparative assessment reveals a persistent gap between heat-health action and health workforce policy across Europe. Progress in heat-health governance does not automatically translate into workforce-specific action. Despite growing recognition of climate-related health risks, HHAPs continue to prioritise health workers as providers of care rather than as a vulnerable population requiring protection, critical health system capacity requiring preparedness, and stakeholders with agency in policy development and implementation. Addressing this gap requires stronger alignment between HHAPs and occupational health frameworks, workforce-specific surveillance and monitoring, greater involvement of professional stakeholders, and more coherent governance across sectors and levels. European coordination could further support these efforts through common guidance, evidence generation and policy learning. Ultimately, workforce resilience and climate-health resilience must be addressed together to ensure health system preparedness, service continuity and health security in an era of increasing climate-related threats.

Policy recommendations

- Integrate workforce-specific measures into HHAPs while connecting them to existing occupational protection requirements, health system planning and organisational preparedness.
- Strengthen the collection and use of comprehensive, disaggregated workforce data to identify vulnerabilities and gender, ethnicity and age-related inequalities, inform equitable and targeted protection measures, and strengthen evidence-based workforce planning and preparedness.
- Strengthen transsectoral governance by systematically engaging a broader range of workforce stakeholders and integrating bottom-up capacities into policy development and implementation.
- Develop a coherent European Union strategy to align policy frameworks, governance mechanisms and funding resources, and provide guidance for context-specific national level actions.

Abbreviations

EU
European Union
GPs
General Practitioners
HCWF
Health and care workforce
HHAP
Heat–Health Action Plans
HSPM
Health Systems and Policy Monitor
LTC
Long–term care
MA
Master degree
MoH
Ministry of Health
n/a
data not available
NHS
National Health Service
OECD
Organisation of Economic Cooperation and Development
OOP

Out–of–pocket payment
OSCC
Observatorio de Salud y Cambio Climático
PHC
Primary health care
PPE
Personal protective equipment
SHI
Social Health Insurance
SNS
Serviço Nacional de Saúde, National Health Service Portugal
SNS
Sistema Nacional de Salud, National Health Service Spain
UHC
Universal health coverage
UK
United Kingdom

Declarations

Funding

This research did not receive any specific grant from funding agencies in the public, commercial sector, or non-for-profit sectors.

Acknowledgements

ZK wants to acknowledge support by the NPO ‘Systemic Risk Institute’ grant (LX22NPO5101), funded by the Next Generation EU (Ministry of Education, Youth and Sports, NPO: EXCELES).

CRediT authorship contribution statement

Ellen Kuhlmann: project coordination, conceptualisation, data collection and analysis, writing – original draft, review & editing; Michelle Falkenbach: conceptualisation, data collection and analysis, writing – original draft, review & editing; Katarzyna Dubas-Jakóbczyk: conceptualisation, data collection and analysis, writing – review & editing; Gunda Waldmann: conceptualisation, data collection and analysis, writing – review & editing; Gabriela Lotta: conceptualisation, analysis, writing – review & editing; Tiago Correia: data collection and analysis, writing – review & editing; Zuzana Kotherová: data collection and analysis, writing – review & editing; Stefano Neri: data collection and analysis, writing – review & editing; Marius-Ionuț Ungureanu: data collection and analysis, writing – review & editing; Gemma A Williams: data collection and analysis, writing – review & editing; Matthias Wismar: writing – review & editing

References

1. European Environment Agency (EEA) (2024a) The impact of heat on health: surveillance and preparedness in Europe. Luxembourg: Eur Union, ; https://www.eea.europa.eu/en/analysis/publications/the-impacts-of-heat-on-health
2. Kluge HHP, WHO Office for the European Region (2026a) Get prepared: current European Region heatwaves are a dress rehearsal. Statement 30 June 2026. WHO, Copenhagen. https://www.who.int/europe/news/item/30-06-2026-statement---get-prepared--current-european-region-heatwaves-are-a-dress-rehearsal
3. Kluge HHP (2026b) Europe’s hot weather: a health emergency hiding in plain sight. Eur J Public Health 36(4):1–2. https://doi.org/10.1093/eurpub/ckag140
4. Kriit H, Chen-Xu J, Semenza J, Heiliger H, Markanday A, Niheer Dasandi P et al (2026) The 2026 Europe report of the Lancet Countdown on health and climate change: narrowing window for decisive health action. Lancet Public Health 11:e386–e407. https://doi.org/10.1016/S2468-2667(26)00025-3
5. Dubas-Jakóbczyk K, Mrożek-Gąsiorowska M, Ndayishimiye C, George NS, Pereyra AB, Waldmann G, Quentin W (2026) Health systems’ responses to climate change: an umbrella review of systematic reviews. Health Policy 105805. https://doi.org/10.1016/j.healthpol.2026.105805
6. Ansah EW, Amoadu M, Obeng P, Sarfo OJ (2024) Health systems response to climate change adaptation: a scoping review of global evidence. BMC Public Health. https://doi.org/10.1186/s12889-024-19459-w. 24:2015
7. Sanchez Martinez G, Kendrovski V, Salazar MA, de’Donato F, Böckmann M (2022) Heat-health action planning in the WHO European Region: status and policy implications. Environ Res 214:113709. https://doi.org/10.1016/j.envres.2022.113709
8. Climate APAPT (2025) Effects on occupational health and safety. Climate ADAPT: Website, ; https://climate-adapt.eea.europa.eu/en/observatory/topics/health-impacts/occupational-safety-health/effects-on-occupational-health-and-safety
9. Jegodka Y, Lagally L, Mertes H, Deering K, Schoierer J, Buchberger B, Bose-O'Reilly S (2021) Hot days and Covid-19: Online survey of nurses and nursing assistants to assess occupational heat stress in Germany during summer 2020. J Clim Change Health 3:100031.

https://doi.org/10.1016j/joclim.2021.100031

10. Zurynski Y, Fisher G, Wijekulasuriya S, Leask E, Dharmayani PNA, Ellis LA et al (2024) Bolstering health systems to cope with the impacts of climate change: a review of the evidence on workforce planning, upskilling, and capacity building. Int J Health Plann Manage 39(3):781–805. https://doi.org/10.1002/hpm.3769
11. Kuhlmann E, Correia T, Falkenbach, Lotta G, Paina L (2026a) The health and care workforce: how to move from crises to capacities? Health Policy 165:105548. https://doi.org/10.1016/j.healthpol.2025.105548
12. Muscat NA, Lazëri L, Zapata T, Kluge H (2025) Protecting the mental health of the health and care workforce in Europe: a strategic investment. Lancet Reg Health Eur 57:101489. https://doi.org/10.1016/j.lanepe.2025.10148
13. World Health Organisation Regional Office for Europe (WHO Europe) (2022) Health and care workforce in Europe: time to act. World Health Organisation, Copenhagen. https://www.who.int/europe/publications/i/item/9789289058339
14. World Health Organisation (WHO) Office for the European Region. Heat health action, 2nd edition. Copenhagen: WHO (2026a) ; https://www.who.int/europe/publications/i/item/9789289062930
15. World Health Organisation (WHO) Office for the European Region (2026b) News, 16 July 2026: Planning for a warmer world. WHO, Copenhagen. https://www.who.int/europe/news/item/16-07-2026-planning-for-a-warmer-world
16. World Health Organization Regional Office for Europe (WHO) (2025) Mental Health of Nurses and Doctors Survey in the European Union, Iceland and Norway. WHO, Copenhagen. https://www.who.int/europe/publications/i/item/WHO-EURO-2025-12709-52483-81031
17. Zapata T, Azzopardi Muscat N, Falkenbach M, Wismar M (2023) From great attrition to great attraction: countering the great resignation of health and care workers. Eurohealth 29(1):6–10. https://www.ehfg.org/fileadmin/downloads/21-press/2023/Eurohealth_EHFG2023.pdf
18. Falkenbach M, Kuhlmann E, Oomen B, Ungureanu MI, Zapata T, Wismar M (2026a) Heat-health action plans overlook Europe's most important health system resource: the health and care workforce. Health Policy 173:105742. https://doi.org/10.1016/j.healthpol.2026.105742
19. Chen TT, Pinho-Gomez A-C, Harmacher N, Nubbe M, Duggan K, Zjalic D et al (2025) Climate and Health Capacity Building for Health Professionals in Europe: A Pilot Course. Int J Public Health 70:1608469. https://doi.org/10.3389/ijph.2025.1608469
20. Clarke J, Blom IM, Campbell-Lendrum D, Kerry V (2025) Health workforce as a climate and health priority in nationally determined contributions. Lancet Planet Health 9(8):101288. https://doi.org/10.1016/j.lanplh.2025.101288
21. Schmidt AE, Brugger K, Horváth I, Falkenbach M, Williams GA, van Schaaijk A et al (2025) Green skills for a sustainable future: building a climate-smart health and care workforce in the European Union, Policy Brief 71. Copenhagen: WHO, European Observatory on Health Systems and Policies, ; https://bewell-project.eu/wp-content/uploads/2025/06/policybrief-bewell-green-skills-v3-23042025.pdf
22. Schmidt AE, Sutton G, Maassen A, Brugger K, Falkenbach M et al (2026) Building a climate-smart health workforce: insights for policy and practice. Eurohealth, ;32(1):9–13; https://iris.who.int/server/api/core/bitstreams/49daaf62-9eb5-4276-926a-41fa81cdcd6a/content
23. Caffrey M, Tancred T, Falkenbach M, Raven J (2023) What can intersectoral governance do to strengthen the health and care workforce? Structures and mechanisms to improve the education, employment and retention of health and care workers. Policy Brief 53.Copenhagen: WHO, ; https://eurohealthobservatory.who.int/publications/i/what-can-intersectoral-governance-do-to-strengthen-the-health-and-care-workforce-structures-and-mechanisms-to-improve-the-education-employment-and-retention-of-health-and-care-workers30 Burau V, Kuhlmann E, Lotta G. Comparative health policy goes qualitative: refocusing research after COVID-19. Int J Health Plann Manage, 2023;38:1135–1141; https://doi.org/10.1002/hpm.3686
24. Geffert K, von der Haar A, Jung M, Otieno MA, Rehfuess E, Schneider A et al (2026) Assessing governance structures for climate-resilient and sustainable health systems: development of the PHONIC framework. J Glob Health 16:04083. https://doi.org/10.7189/jogh.16.04083
25. Geffert K, Voss S, Rehfuess E, Rechel B (2024) The role of the public health service in the implementation of heat health action plans for climate change adaptation in Germany: A qualitative study. Health Res Policy Sys 22:161. https://doi.org/10.1186/s12961-024-01231-6
26. Falkenbach M, Joachim M, Wismar M, Williams GA, Correia T, Czabanowska K et al (2026) b;174 Leadership for implementation is essential to turn health workforce ambition into reform. Health Policy; : 105765; https://doi.org/10.1016/j.healthpol.2026.105765
27. Kuhlmann E, Rees GH, Falkenbach M, Williams GA, Wismar M (2026b) Moving towards a resilient health and care workforce: how to institutionalize planning and forecasting? Policy Brief 79. Copenhagen: WHO, European Observatory on Health Systems and Policies, ; https://eurohealthobservatory.who.int/publications/i/moving-towards-a-resilient-health-and-care-workforce-how-to-institutionalize-health-workforce-planning-and-forecasting
28. European Environment Agency (EEA) (2022a) ClimatAdapt. Status of national climate adaptation and health policies. European Union, Luxembourg. https://climate-adapt.eea.europa.eu/en/observatory/policy/national-policies/status-national-policies
29. European Environment Agency (EEA), Climate-ADAPT. Nurses climate challenge Europe: A campaign to engage health professionals on the impacts of climate change on health. Luxembourg: European Union (2022b) ; https://climate-adapt.eea.europa.eu/en/observatory/++aq++metadata/case-studies/nurses-climate-challenge-europe-a-campaign-to-engage-health-professionals-on-the-impacts-of-climate-change-onhealth?bs=1&langflag=1
30. Burau V, Kuhlmann E, Lotta G (2023) Comparative health policy goes qualitative: refocusing research after COVID-19. Int J Health Plann Manage 38:1135–1141. https://doi.org/10.1002/hpm.3686
31. Kuhlmann E, European Parliament (EP) (2025) : Directorate-General for Economy, Transformation and Industry. The health workforce crisis in the European Union – Policy options for improving the sustainability of healthcare systems and employment and working conditions in the healthcare sector. Brussels: European Parliament, ; https://doi.org/10.2861/3098897; https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/772481/ECTI_BRI(2025)772481_EN.pdf

32. Johar H, Abdulsalam FI, Guo Y, Baernighausen T, Jahan NK, Watterson J et al (2025) Community-based heat adaptation interventions for improving heat literacy, behaviours, and health outcomes: A systematic review. Lancet Planet Health 9:101207. https://doi.org/10.1016/S2542-5196(25)00007-5
33. Kuhlmann E, Falkenbach M, Lotta G, Correia T, Domagala A, Kihlström L et al (2027) The health and care workforce in Europe's emerging health security architecture: A comparative assessment of selected European Union countries. Health Policy 105802. https://doi.org/10.1016/j.healthpol.2026.105802
34. Greer SL, Zimmermann J, Sagan A, Cooney K, Figueras J (2023a) What could the EU do to build resilient health systems and resilient, healthy societies? Eurohealth 29(3):14–21. https://iris.who.int/handle/10665/375424
35. Saulnier DD, Duchenko A, Ottilie-Kovelman S, Tediosi F, Blanchet K (2023) Re-evaluating our knowledge of health system resilience during COVID-19: lessons from the first two years of the pandemic. Int J Health Policy Manag 12:6659. https://doi.org/10.34172/ijhpm.2022.6659
36. Zimmermann J, Karanikolos M, Cylos J, McKee M (2024) We need a combination of approaches to evaluate health system resilience. Int J Health Policy Manag 13:8564. https://doi.org/10.34172/ijhpm.8564
37. Lotta G (2026) Street-level Bureaucrats in Vulnerable Contexts: Navigating vulnerabilities in Brazil. Policy, Bristol. https://policy.bristoluniversitypress.co.uk/street-level-bureaucrats-in-vulnerable-contexts
38. Kuhlmann E, Lotta G, Beja A, Burau V, Gershuni O, Kotherová Z et al (2026c) Health and care workforce-driven transformations can improve workforce stability and strengthen health system resilience. Eur J Public Health 36(6):ckag185. https://doi.org/10.1093/eurpub/ckag185
39. European Union. EuroStat. Current healthcare expenditure (2023) Brussels: EU, 2026; https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthcare_expenditure_statistics_-_overview#Healthcare_expenditure
40. European Observatory on Health Systems and Policies (OBS). Health Systems and Policy Monitor (HSPM). Website, country cases (2026) ; https://eurohealthobservatory.who.int/monitors/health-systems-monitor/overview
41. World Health Organisation (WHO) (2024) Universal Health Coverage (UHC) progress. UHC service coverage index, Official estimate. WHO, Geneva. https://data.who.int/indicators/i/3805B1E/9A706FD
42. European Observatory on Health Systems and Policies (OBS) (2022) England: Health Systems Monitor 2022. WHO, Copenhagen. https://eurohealthobservatory.who.int/monitors/health-systems-monitor/countries-hspm/hspm/hspm-united-kingdom-2022
43. OECD. Health statistics, Paris OECD (2026) ; https://www.oecd.org/en/data/datasets/oecd-health-statistics.html
44. OECD (2025) Figure 7.1. Health expenditure as a share of GDP, 2024 (or nearest year). Paris. OECD. https://www.oecd.org/en/publications/2025/11/health-at-a-glance-2025_a894f72e/full-report/health-expenditure-in-relation-to-gdp_6e4c2773.html
45. Bundesgesundheitsministerium (BMG) (2025) Roadmap zur Weiterentwicklung des „Hitzeschutzplans für Gesundheit des BMG. BMG, Berlin. https://www.bundesgesundheitsministerium.de/fileadmin/Dateien/3_Downloads/H/Hitzeschutzplan/BMG_Roadmap_Hitzeschutzplanung_Sommer_202
46. Czech Ministry of Environment. National Climate Change Adaptation Action Plan. Prague: Ministry of Environment (2021) ; https://mzp.gov.cz/cz/agenda/klima-a-energetika/adaptace-na-zmenu-klimatu
47. Government of Romania Decision no. 1010/2024 approving the National Strategy on Adaptation to Climate Change for the period 2024–2030, with a perspective of 2050 [Internet]. Official Gazette of Romania, Part I, no. 823, 19 August 2024; https://legislatie.just.ro/public/DetaliiDocument/287810
48. Ministerio di Sanidad (2026) Plan nacional de actuaciones preventivas de los efectos del exceso de temperatura sobre la salud. Madrid: Ministerio di Sanidad, ; https://www.sanidad.gob.es/areas/sanidadAmbiental/riesgosAmbientales/calorExtremo/publicaciones/docs/planNacionalExcesoTemperaturas_2026.p
49. Ministere de lasante, des familles, de l'autonomie et des personnes handicapees. Health management of heat waves. Ministere de la sante, website (2026) ; https://sante.gouv.fr/sante-et-environnement/risques-climatiques/article/la-gestion-sanitaire-des-vagues-de-chaleur
50. Ministério da Saúde. Portaria n. 136/2026/1, de 31 de março. Estabelece o modelo nacional de preparação e resposta sazonal em saúde. Diário da República (2026) ;1.ª série(63):1–7; https://files.diariodarepublica.pt/1s/2026/03/06300/0002000026.pdf
51. Ministero della Salute Piano nazionale per la prevenzione degli effetti del caldo sulla salute, in Ministero della Salute. Linee di indirizzo per la prevenzione. Ondate di calore e inquinamento atmosferico, cap. 2. Ministero della Salute, website, July 2026a; https://www.salute.gov.it/new/sites/default/files/2026-07/LG%20CALDO%20INQUINAMENTO%20AGG%202026_0.pdf
52. Government UK, Health Security Agency (2026) Adverse Weather and Health Plan: protecting health from weather related harm, 2026 to 2027. Health Security Agency, London. https://www.gov.uk/government/publications/adverse-weather-and-health-plan
53. NHS England–World Health Organization Collaborating Centre (2026) The Climate Crisis is a Health Workforce Crisis. Working for Health 2030–2026/27 Seminar Series. NHS, London. https://www.youtube.com/playlist?list=PLrVQaAxyJE3eJiTArG8BPwH_6uyQGF1pa
54. Global Heat Health Information Network, UNDRR, WMO (2025) Narrative Analysis: Case studies in heat resilience. WMO, Geneva. https://heathealth.info/wp-content/uploads/Narrative-Analysis-of-Case-Studies-6.pdf
55. Williams GA, Ziemann M, Chen C, Forman R, Sagan A, Pittman P (2024) Global health workforce strategies to address the COVID-19 pandemic: learning lessons for the future. Int J Health Plann Manage 9:888–897. https://doi.org/10.1002/hpm.3762
56. Raven J, Witter S, Bertone MP, Regmi S, Hawkins K, Osborne A et al (2026) Supporting a resilient health workforce: Lessons from health systems experiencing shocks. SSM–Health Syst 7:100257. https://doi.org/10.1016/j.ssmhs.2026.100257
57. Kruger K, Brysiewicz P, Lori J, Bell SA (2025) The role of the nursing workforce in health system resilience during disasters: a scoping review of empirical studies. Int J Nurs Stud Adv 9:100361. https://doi.org/10.1016/j.ijnsa.2025.100361
58. Royal College of Nursing (RCN) Press release. 3 in 4 nursing staff say government not doing enough to protect services from climate change, as devastating testimony shows harm done to patients this summer. RCN, website, 18 September 2026; https://www.rcn.org.uk/news-and-events/Press-Releases/3-in-4-nursing-staff-say-government-not-doing-enough-to-protect-services-from-climate-change

59. Stacciarini J-M, Kruger K, Bell SA (2026) Healing minds on a warming planet: what is the role of mental health nurses in climate resilience? J Psychosoc Nurs Ment Health Serv 64(5):3–5. https://doi.org/10.3928/02793695-20260414-03
60. Stuart-Ruano A, Spriggs R, Lawrence EL, Massazza A, Czerniewska A, Saez Reale A et al (2025) A critical gap in addressing mental health in Heat-Health Action Plans worldwide. Curr Envir Health Rpt 12:23. https://doi.org/10.1007/s40572-025-00486-7
61. International Association of National Public Health Institutes (IANPHI). IANPHI roadmap for action on health and climate change. Website (2021) November ; https://ianphi.org/_includes/documents/sections/tools-resources/climate-change/roadmap-climate-english.pdf
62. Association of Schools of Public Health in the European Region (ASPHER) (2021) ASPHER Climate and Health Competencies for Public Health Professionals in Europe. ASPHER, Brussels. https://www.aspher.org/download/882/25-10-2021-final_aspherclimate-and-health-competencies-for-public-health-professionals-in-europe.pdf
63. Fortunato R, Ragetti MS, Gerosa T, Dratva J, Baumann I (2026) Occupational heat strain among home health care workers: a cross-sectional study. BMC Public Health 26:2690. https://doi.org/10.1186/s12889-026-28969-8
64. Wilson M, De Raeve P, Henderson N, Letters (2026) Plans must be put in place before heatwaves – not cobbled together during them. Guardian, ; https://www.theguardian.com/environment/2026/jul/02/plans-must-be-put-in-place-before-heatwaves-not-cobbled-together-during-them
65. Greer SL, Falkenbach M, Siciliani L, McKee M, Wismar M, Vissapragada P et al (2023b) Making health for all policies: harnessing the co-benefits of health, Policy Brief 50. Copenhagen: WHO, European Observatory on Health Systems and Policies, ; iris.who.int/server/api/core/bitstreams/8c21a98f-c97b-43e2-8a4c-9b7e0d79bce7/content
66. European Environment Agency (EEA) (2026) Overheated and underprepared: Europeans' experience of living with climate change. Website, 23 March 2026. Luxembourg: Eur Union, ; https://climate-adapt.eea.europa.eu/en/observatory/publications-data/observatory-publications/overheated-and-underprepared-europeans-experience-of-living-with-climate-change
67. Wismar M, Margheri F (2026) BeWell – a blueprint for skills and skill-mix development in the health workforce. Eurohealth, ;32(1):2; https://iris.who.int/server/api/core/bitstreams/49daaf62-9eb5-4276-926a-41fa81cdcd6a/content
68. Wismar M, Goffin T (2023) Towards a European health workforce. Eurohealth, ;29(3);22–26; https://iris.who.int/bitstream/handle/10665/375425/Eurohealth-29-3-22-26.pdf?sequence=1
69. Falkenbach M, Troch T, Grech K, Williams GA, Wismar M (2027) How do countries design and govern staffing levels? A comparative analysis of European approaches. Health Policy 105803. https://doi.org/10.1016/j.healthpol.2026.105803