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Original Article

Collective bargaining and social dialogue as instruments to protect workers from heatwaves and climate change in the European Union

Alberto RIESCO-SANZ[1]

[1]University Complutense of Madrid-TRANSOC, Spain

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Abstract: This article presents a comparative analysis of how collective bargaining and social dialogue contribute to protecting European workers from the effects of high temperatures linked to climate change. The study focuses on five European countries—Spain, Italy, Greece, the Netherlands, and Hungary—which together provide a comprehensive and nuanced overview of the current situation across Europe. The methodology is primarily qualitative, based on 11 case studies (covering both sectors and companies), 60 interviews with key informants, and an in-depth analysis of the existing legal framework for heatwave prevention in both public health and occupational safety and health (OSH) contexts. The study also includes a detailed review of collective agreements and other social dialogue tools—such as heat action plans and OSH catalogues—to assess the extent to which high temperatures are addressed in collective bargaining in the selected countries. The empirical evidence reveals that high temperatures are still only marginally addressed in European collective bargaining, and significant challenges remain. Nevertheless, the fieldwork also identified several initiatives which, despite their limitations, represent steps forward in worker protection and could serve as examples of good practice.

Key words: Collective bargaining, Social dialogue, Collective agreements, Heatwaves, Heat stress, Occupational safety and health, European Union

Introduction

The scientific evidence indicates that climate change is contributing to an increase in the frequency of extreme heat events around the world, with heat waves becoming both more frequent and intense. It is important to note that these phenomena are no longer confined to the hottest months of the year, and their duration is also increasing. Furthermore, the effects of these phenomena are being felt more acutely in countries that are usually less exposed to high temperatures[1–4]. In recent years, the health impact of climate change and, more specifically, of high temperatures, has been repeatedly emphasised, thus highlighting a growing awareness of the relevance of this type of phenomenon for public health[5–10]. Among the measures implemented by governments to mitigate the impact of heat waves on health, there is a paucity of initiatives specifically targeting the world of work, despite the fact that workers are among the most vulnerable groups to the adverse effects of heat and high temperatures.

Heat associated with the use of machinery or certain production processes, the use of personal protective equip-

To whom correspondence should be addressed.
E-mail: albertoriesco@ucm.es

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ment, the physical exertion required in certain occupations or prolonged exposure to solar radiation are factors that increase the risk of heat stress among workers. The negative effects of heat on the health and productivity of workers are widely known[11–14], to the point that heat is often considered a risk factor that should be prevented[15]. It is important to note that heat waves serve to accentuate and amplify the risks of "heat stress" faced by workers, rendering them particularly vulnerable to the effects of climate change[12, 16–20].

This situation has prompted various organisations to emphasise the significance of incorporating the world of work into policies and actions against the effects of climate change[21–24]. From this standpoint, the involvement of social agents is imperative for the accurate identification of novel risks associated with climate change, as well as for the formulation of effective protection measures against them. Collective bargaining and other forms of social dialogue are thus a key instrument to ensure a just transition that protects workers from the risks associated with climate change[22, 25–27].

This article draws on the results of the ADAPTHEAT project, which was conducted in five European countries (Spain, Italy, Greece, the Netherlands and Hungary)[1]. It carries out a comparative analysis of the impact of collective bargaining and social dialogue on protecting European workers from the effects of high temperatures linked to climate change. The empirical material collected has allowed us to note the still rather limited presence of high temperatures in European collective bargaining, which is exposed to major difficulties that we have tried to identify and systematise. However, the fieldwork has also enabled us to identify some initiatives which, despite their limitations, represent an improvement in worker protection and could serve as cases of good practice.

The article commences in Section 2 with a concise overview of the study's methodology and the provenance of the data. The primary results of the study are outlined in section 3. The analysis in Section 3.1 examines how heat waves have been gaining prominence in the public health actions of the five countries analysed, while maintaining a much more modest presence in terms of OSH actions. Section 3.2 then analyses the presence of heat stress linked to climate change in the content of collective agreements and other forms of social dialogue (heat plans, OSH catalogues, etc.) in the countries investigated. Finally, section 3.3 provides a comprehensive overview of the findings from the concrete bargaining experiences analysed in the selected case studies (sectoral and company). The article concludes in Section 4 with a brief summary of the main findings and the bibliography, which is outlined in Section 5.

Methodology

The article employs a comparative analysis of the role played by collective bargaining in protecting workers from the effects of heat waves. The study focuses on five European countries (Spain, Italy, Greece, the Netherlands and Hungary) that vary in their exposure to high temperatures, industrial relations systems and socioeconomic realities. While these countries may not represent the full diversity of European regions, they facilitate a comparative analysis of the experiences of countries that have been exposed for a longer and more sustained period to the effects of heat waves (Spain, Italy, Greece) and countries where the detrimental impacts of heat waves are a relatively recent but growing concern (Hungary, the Netherlands). At the same time, it allows us to contrast the experiences of labour relations systems that guarantee a high degree of collective bargaining coverage (Spain, the Netherlands and Italy, always above 75% of the employed) and systems where collective bargaining coverage is much more limited (Greece, Hungary, which do not exceed 25% of the employed). The selected countries also reflect models of labour relations where union presence and worker participation vary significantly. These countries include those with high levels of worker participation, such as the Netherlands, medium levels, such as Spain and Italy, and low levels, such as Greece and Hungary. While these results cannot be extrapolated to the entire European Union, they offer a comprehensive and nuanced perspective on the current situation across Europe.

The present study adopted a qualitative methodology, focusing on the analysis of various case studies. Each of the national teams selected two case studies (with the exception of Hungary, where there were three) in order to ensure that there were significant cases for the study of worker protection against heat risks. The objective of the study was to identify sectors with a high degree of exposure to heatwave risks, primarily—though not

[1] ADAPTHEAT is an EU-funded research project (Call: SOCPL-2021-IND-REL) that ran from 2022 to 2024. The project was coordinated by Claudia Narocki, Sergio Salas-Nicás, and Valeria Uberti-Bona, all affiliated with ISTAS-Fundación Primero de Mayo (https://1mayo.ccoo.es/Centros/ISTAS/Presentación). The empirical material presented in this article is based on fieldwork carried out by researchers from the various national teams involved in the project. Full project results and information about the research teams are available at: https://istas.net/adaptheat_eng.

exclusively—those where work is predominantly conducted outdoors, including construction, agriculture, water management, select logistics activities and ship repair. The repercussions of extreme heat on the health of workers extend beyond those engaged in outdoor occupations. A thorough analysis has been conducted on sectors whose activities are predominantly conducted indoors. These sectors include the food industry, logistics, administrative services and educational establishments.

The selection of cases has attempted to combine analyses of a more sectoral nature with analyses focused on specific companies. In all cases, beyond the significance of the sector itself (economic weight, number of employees, impact of heatwaves, etc.), the aim was to prioritise cases in which there is some kind of initiative to protect workers from the effects of heatwaves. The objective of the present study was twofold: firstly, to assess the scope of such initiatives and potential impediments to their execution; secondly, to evaluate the role of social dialogue and worker involvement in the process. A number of these case studies are presented as exemplars of best practice, i.e. instances in which issues pertaining to the safeguarding of workers' health in relation to heat have been addressed with marked effectiveness. In other instances, the selected cases have also served to highlight the difficulties faced in protecting workers from heat exposure.

In all the analyses, the national teams collected different types of information on each case analysed (size of the sector and/or company analysed, type of impact of heat exposure, OSH regulations in force in the sector, social dialogue and collective bargaining mechanisms in place, etc.). At the same time, in-depth interviews were carried out with a range of strategic actors in the sector. These included trade union and company representatives, as well as experts in the prevention of occupational hazards and OSH policy-makers. The interviews were conducted online and in person throughout 2023, using a semi-structured script adapted to the profile of the interviewee. All interviews were recorded and their content analysed together with the rest of the empirical material collected. The following Table 1 presents a summary of the case studies and interviews that were carried out (a detailed list of the key informants interviewed can be found in Appendix Table 1).

In addition to the case studies and in-depth interviews with key informants, the various national teams carried out an exhaustive analysis of the existing legal framework for heat wave prevention (both in the public health and OSH fields). A detailed analysis of the content of collective agreements and other social dialogue instruments (heat action plans, OSH catalogues) was also carried out to verify the presence of high temperatures in collective bargaining in the countries investigated. The analysis conducted in this respect is summarised in Table 2 (for further details, refer to the national case studies in this special issue of Industrial Health).

Results

The emergence of heatwaves on the European social and political agenda

In the case of the five countries analysed in the present study, despite the evident differences and the varying degrees of development of their policies to address climate change, the phenomenon of "climate change"—and more specifically, heatwaves—has been clearly identified as a public health problem in all of them (see Table 3). The growing mobilisation of citizens and the scientific community against the effects of climate change, as well as the accumulation of an increasing amount of empirical evidence on the impact of climate change on our lives, has driven the public debate on the need for and urgency of adopting measures to curb and reverse the present and future effects of climate change. Health is undoubtedly one of the areas where the impact of climate change can

Table 1. Case studies and in-depth interviews that were carried out in the course of the ADAPTHEAT project

	Spain	Italy	Greece	Netherlands	Hungary
Case study 1	Water management company	Agriculture sector	Food sector company	Agriculture sector and company	Agriculture sector and company
Case study 2	Construction sector	Logistics sector	Ship repair sector	Construction sector company	Administrative services company
Case study 3					Education sector
Key informant interviews	12	12	18	10	8
TOTAL	11 case studies and 60 in-depth interviews with key informants				

Source: [28]. A detailed list of the key informants interviewed can be found in Appendix Table 1.

Table 2. Collective agreements and other social dialogue instruments analysed during the ADAPTHEAT project

Spain	-Analysis of 600 collective agreements (signed between 2020 and 2025) available in the REGCON database of the Ministry of Labour and Social Economy. -Analysis of 16 heat action plans approved in several Spanish companies.
Italy	-Analysis of national, sectoral, and territorial protocols signed by institutional actors and industrial relations stakeholders (including trade unions, employers' associations, local authorities, and inspection bodies).
Greece	-Analysis of the Organisation for Mediation and Arbitration (OMED)'s database to identify collective agreements with references to high temperatures. -Content analysis of 22 sectoral collective agreements with reference to high temperatures.
Netherlands	-Analysis of 1,100 collective labour agreements. These were found in two databases. One was hosted by the Dutch Ministry of Social Affairs and Employment. The other was hosted by the trade union FNV. -Analysis of 149 OSH catalogues that have been notified to the Labour Inspectorate. -Analysis of 17 sectoral risk assessment tools.
Hungary	Analysis of collective agreements, employers' resolutions and risk assessment documents from the agricultural, railway, commercial and education sectors.

Source: [28].

Table 3. Main government initiatives implemented in the countries analysed to combat the effects of heatwaves on the population's health

Spain	-National Plan of Preventive Actions on the Effects of Excess Temperatures on Health (PNAPET), 2004 and 2023. -National Plan for Adaptation to Climate Change (PNACC), 2006–2020 and 2021–2030. -Declaration on the Climate and Environmental Emergency in Spain, 2020. -Law 7/2021 of 20 May on climate change and energy transition. -Strategic Plan for Health and Environment (PESMA) 2022–2026. -Launch of the Ministry for Ecological Transition and the Demographic Challenge, the Institute for Just Transition (ITJ), the Secretary of State for the Environment, and the Health and Climate Change Observatory, 2018.
Italy	-Heatwave warning system, 2003. -First prevention plan for the effects of heat on health, 2005 (reformulated several times since then). -National portal with data from the Ministry of Health on heatwaves, 2005.
Greece	-National Climate Law (Law 4936/2022), 2022. -National Public Health Action Plan (2021–2025), 2021.
Netherlands	-National Heat Plan, 2007 (reformulated several times since then). -National action plan on skin cancer, 2021.
Hungary	-National Climate Protection Authority, 2014. -National Energy and Climate Plan, 2019. -Law No. XLIV 2020 on Climate Protection, 2020.

Source: [28].

be felt, and this is reflected to a greater or lesser extent in all the European countries we have analysed.

In all the countries under scrutiny, it is widely acknowledged that climate change represents a significant risk to public health. This is not only due to the potential for catastrophic meteorological events such as river floods, torrential rains and hurricanes, but also as a persistent public health concern that necessitates the implementation of policies, institutions, coordination mechanisms and resources. In this regard, the rising incidence of heatwaves, which are becoming more frequent and intense, represent a significant challenge to public health, as demonstrated by excess mortality data during heatwaves[29–31].

In line with this situation, all five countries analysed (see Table 3) have been implementing early warning systems, action plans and information campaigns to try to prevent the adverse effects of heatwaves on the health of the general population (although we cannot assess the design and effectiveness of these measures here). In summary, while we cannot confirm the presence of this phenomenon with equal intensity and consistency across all the countries analysed, our comparative research has confirmed the emergence of heatwaves as a public health concern in all of them. This has been reflected in the implementation of different measures, the mobilisation of resources and, in some cases, even in the transformation of the formal

organisation of the State Administration.

Heatwaves: from public health issue to occupational health issue?

As previously mentioned, all of the countries under scrutiny have initiated measures to address heatwaves as a public health concern. In many cases, these are recent initiatives that are not yet fully implemented, or that are limited in scope, often based on voluntary measures and recommendations. In addition to the aforementioned limitations, a further significant problem is that the safety and well-being of workers is frequently disregarded or only marginally considered in this category of public health initiative targeting the general population.

Nevertheless, there are indications that this situation is undergoing gradual change in certain countries. The objectives of the climate change strategies and action plans that are being approved in some of the countries analysed are beginning to include the protection of workers' health from the consequences of climate change, with climate change being (implicitly) recognised as an occupational hazard. Conversely, certain strategies and proposals for action have identified specific groups of workers (e.g. those who work outdoors) as being at risk and thus deserving of specific protection measures against heatwaves.

In Spain, for instance, the National Plan for Adaptation to Climate Change (PNACC) 2021–2030[32)] calls for the implementation of preventive measures against the effects of climate change on workers' health. This is partly due to the recognition that climate change poses new occupational hazards and exacerbates existing ones. The Plan acknowledges that a wide range of occupations are susceptible to heat-related risks. It recommends incorporating climate change factors into workplace risk assessments, developing preventive measures, and implementing specific programmes to protect the most vulnerable workers. Similarly, in 2021, the first regional ordinance to protect agricultural workers from the effects of heatwaves was approved in the Italian region of Puglia[33)]. This ordinance included measures such as banning work during the hottest hours. This constitutes a significant change, as it marks the first instance in which the actions of the regional authorities will no longer be directed towards the general population or vulnerable groups, but rather a specific group of workers. In the Netherlands, the National Heat Plan approved in 2007[34)] does not address the impact of heat exposure on workers. However, certain groups of workers must be considered populations that require specific protective measures. Despite these advances, the protection of workers' health remains underdeveloped in the heatwave actions undertaken in the five countries analysed. The general trend continues to be one of public health action addressing the impact of heat exposure on the population (or on certain risk groups), with little or no attention to the specific needs of workers. However, the world of work is increasingly concerned about the impact of heatwaves on workers' safety and health.

In the Mediterranean countries analysed, trade unions and workers have been expressing a growing concern about the effects of heat exposure for some years now. This concern also extends to the Central and Northern European countries investigated[2]. This situation is reflected in the actions taken by trade unions in the five countries analysed, where (especially in southern Europe) there is a succession of information and denunciation campaigns. Trade unions are also attempting to include content regarding heatwaves and heat stress in the scope of collective bargaining and occupational hazards prevention[23, 24, 35)], though with limited success to date. The increased interest in the impact of heatwaves on workers' health is also reflected in other relevant actors in industrial relations, such as the ILO, the Labour Inspectorate or the bodies responsible for defining and implementing OSH policies[12, 22, 36)]. All of them have increased their interest in, and some have taken action on, the phenomenon of heatwaves. For example, the Labour Inspectorate in several countries (Spain, Italy, Greece, Netherlands) has launched information campaigns and verified companies' prevention plans[28)].

Despite this, the increased interest in heatwaves has not yet resulted in greater attention to labour-specific problems in strategies and action plans designed to address the effects of climate change. In summary, it appears that labour-related issues have not significantly influenced the discourse on heatwaves and climate change. However, could there be an influence in the opposite direction? Could environmental issues linked to climate change perhaps be spreading into the world of work (e.g. in the field of occupational safety and health)?

Heat exposure in the context of occupational hazards prevention

It appears that the issues of heatwaves and climate change are not yet being given due consideration in the field of occupational safety and health. Despite the fact

[2] For example, in 2021, the Dutch trade union FNV surveyed 5,500 of its members about their working conditions. In terms of occupational health, "heat stress" emerged as the third of their concerns[28)].

Table 4. Presence of the heatwave problem in the OSH regulations of the investigated countries

Spain	Occupational hazard regulations (Law 31/1995 and Royal Decree 486/1997) have long set temperature and humidity limits in workplaces. However, they have two main limitations: i) They allow broad employer discretion by requiring only "reasonable" protection from inclement weather (for outdoor work), reducing worker safeguards; and ii) they define "workplace" narrowly, excluding many heat-exposed jobs. Under Royal Decree-Law 4/2023, companies must implement protection against adverse weather, including suspending work during hazardous conditions. They are also required to adapt working conditions—such as adjusting hours—when orange or red weather alerts are issued and current measures are insufficient. The regulation considers task and worker characteristics in risk assessments, expands protection to previously excluded situations, and ensures wage protection despite reduced working time. Limitation: the alert system triggering these measures is based solely on ambient temperature. In 2024, after severe flooding in parts of Spain, RD 8/2024 was enacted to protect workers from extreme weather during work and commutes. It requires all Spanish companies to implement action protocols for adverse conditions, including heat waves. Finally, it is worth mentioning that the effects of rising temperatures on workers due to climate change are one of the six central objectives of the current Spanish Occupational Safety and Health Strategy 2023–2027. This Strategy has been negotiated and approved by the state and regional public administrations, together with Spanish trade unions and business associations. The explicit inclusion of climate change as an occupational risk factor may encourage its incorporation into collective bargaining in the future.
Italy	Italy's Occupational Health and Safety Law (81/2008) requires temperature regulation in the workplace, considering factors like physical activity, tools, humidity, and draughts. To assess heat stress risk, it promotes standards like the Heat Index Chart, which account for both temperature and humidity. Since 2017 (Circular No. 139/2016), employers can request ordinary redundancy pay when work is fully or partially suspended due to adverse weather (e.g., temperatures ≥35 °C), mainly for outdoor work or heat-generating activities that pose health risks. Royal Decree 98/2023 expands access to ordinary redundancy pay for more sectors affected by adverse weather. It defines heat exposure risk levels and stresses the need for prevention systems linking climate change, productivity, and worker health.
Greece	Law 3850/2010 requires employers to include heat stress prevention in occupational risk plans for all work environments. Other regulations also address protection from heat and bad weather (Presidential Decree 305/1996, 70/1996, 16/1996, 176/1997; Mining and Quarrying Regulations-KMLE, 2011). Annual Ministry circulars provide detailed measures for indoor and outdoor work, but except in rare cases (e.g., 2023 heatwave), these are recommendations, not mandatory.
Netherlands	Heat exposure has received little attention as a workplace risk. Dutch OSH laws lack threshold values, and the Ministry of Social Affairs and Employment has not launched any heat-related workplace safety programs.
Hungary	Hungarian occupational safety laws (Act XIII/1993 and related Decree) set temperature limits for work and require employers to ensure compliance. They provide general measures for all work and specific rules for indoor tasks.

Source: [28]. For more details see the national case studies in this special issue of Industrial Health. OSH: occupational safety and health.

that the temperature in workplaces is regulated in all the countries analysed, there is a lack of focus on the effects of extreme temperatures on workers' health. The analysis of the five countries selected indicates a growing interest in heatwaves in the field of occupational hazards prevention (see Tables 4 and 5). However, this interest is not always reflected in the implementation of effective heat protection and prevention measures. The analysis of the five countries selected indicates a growing interest in heatwaves in the field of occupational health and safety. However, this interest is not always reflected in the implementation of effective heat protection and prevention measures.

In general, it can be stated that, despite the progress made in some countries and the increased interest in these issues, the presence of heatwaves in occupational safety and health is still limited. It is true that the regulatory frameworks of most of the countries analysed define the maximum and minimum temperatures to which workers may be exposed during their work (sometimes also the maximum exposure time). These regulations also indicate the employer's responsibility to ensure compliance with these temperature thresholds by means of a hazards assessment that considers the effect of heat exposure, and prevention plans if the thresholds are exceeded. Our research has also enabled us to observe a greater awareness of the effects of heat exposure on workers' health (including in central and northern European countries), as well as the importance of dealing with heat as an occupational hazard that requires different types of action (information and training, technical and organisational measures, etc.).

Despite this, in almost every country we have found incomplete regulatory developments: restrictive defini-

Table 5. OSH Regulations and heat exposure [yes, no]

	Spain	Italy	Greece	Netherlands	Hungary
There are maximum/minimum temperature thresholds set in the regulations.	Yes (interior)	Yes	Yes	No	Yes
Regulations establish the employer's responsibility to ensure compliance with temperature thresholds.	Yes	Yes	Yes	Yes	Yes
Hazards assessments include heat stress as an occupational hazard.	Yes	Yes	Yes	Implicit in the general obligation to perform Risk Assessment	Yes
The risk of exposure to heat stress is measured solely on the basis of air temperature.	No	No	No	N.A.	No
The regulations exclude important sectors or work situations from protection against heat exposure.	No (since 2023)	No	Yes	No	Yes
The regulation sets out detailed prevention measures for both indoor and outdoor work.	No	No	Yes	No	Yes
The legislation provides for the possibility of work stoppage in the event of heat exposure.	Yes	Yes	Yes	Not explicit	Yes
Work stoppage due to heat exposure results in a loss of wages for workers.	No	No[(a)]	No	Yes[(b)]	Yes
There is a single warning system for the activation of heat exposure protection measures.	No	Yes	Yes	Not for workers	Yes

Source: [28]. [(a)] In the Italian case studies, there is a gap between formal policies and real opportunities for workers to act. [(b)] For temporary workers and "independent" (self-employed) workers. OSH: occupational safety and health.

tions of "workplace", little specification of protection in the case of outdoor activities, exclusion from the regulatory framework of certain work situations exposed to heat, inadequacy of the regulations in relation to scientific evidence, measurement of the risk of heat stress based solely on air temperature, etc. These shortcomings vary from country to country and, in some cases, have been or are being partially corrected.

In addition to the aforementioned issue, a further concern has come to light: the non-application of the principles of the current regulations in many companies. This problem is present in every country (especially in small and medium-sized enterprises), with varying degrees of intensity and for different reasons. In many countries, for example, legislation on the prevention of occupational risks establishes general principles of protection (such as a general obligation to perform a risks assessment). However, these principles are often not sufficiently developed (either in legislation or in collective bargaining) in terms of the specific measures to be adopted and how they are to be implemented. It is common for the proposed protective measures to be voluntary, and labour inspectorates often lack the capacity or motivation to verify their implementation. This would be further compounded by several issues, including: a lack of information and awareness regarding the risks of heat exposure in many countries, employers' reluctance to adopt preventive measures that often entail a financial cost for the company, and a weakening of trade union presence.

Finally, our study has identified a further relevant problem: namely, the scarcity of statistics and the lack of consensus on how to measure the risk of exposure to heat stress. In general terms, reliable records of heat stress pathologies and morbidity, as well as data on occupational accidents due to heat exposure, are not available. Some agencies responsible for providing labour statistics are beginning to incorporate information on "heatwaves" into their statistical operations. However, there is still a great lack of knowledge about the true impact of heat on workers' health. It appears evident that effective protection policies are challenging to formulate in the absence of reliable information.

The comparative analyses carried out in the five countries selected also reveal discrepancies in the definition of heat exposure warning systems. These systems are often not harmonised (even within the same country) and may use different methodologies or risk scales. This can undermine the effectiveness of preventive actions. Furthermore, despite the scientific community reaching a consensus that air temperature is an inadequate metric for measuring the risk of heat exposure, heatwave action plans in the workplace continue to be primarily based on air temperature estimates provided by meteorological agencies. However, other fundamental dimensions, such as

humidity, the characteristics of the workplace, the activity performed, or the worker, are often ignored in the design and implementation of warning systems. The systems for measuring the risk of heat stress are not aligned with the available scientific evidence, despite the development of different types of instruments and applications to facilitate the use of these indicators[3].

Collective bargaining and social dialogue can serve as effective tools to address some of these challenges, thereby enhancing the protection of workers against the risks posed by heat exposure and climate change. What is the experience of the five countries analysed in this respect? With regard to the protection of workers from heat exposure, has collective bargaining been able to provide more detailed guidance on the general guidelines contained in the OSH regulations?

Presence of heat exposure in European social dialogue and collective bargaining

It has been demonstrated that current occupational safety and health policies have been inadequate in addressing the implications of climate change for workers' health. Despite the focus on temperature regulation within workplaces, all the analysed countries have shown deficiencies in their response to this critical issue. It is becoming increasingly evident that the actions undertaken in the field of occupational safety and health are encountering significant challenges that have a considerable impact on their ability to protect workers from heat exposure. Firstly, the existing regulatory framework is often inadequate or overly generic, which hinders the implementation of specific and effective protection measures. Secondly, many of the proposed measures for action are not mandatory, but rather offer recommendations for companies. Finally, the application of OSH regulations on protection against heat exposure is not always guaranteed due to the following reasons:

• The lack of awareness among workers, employers and experts of the risks associated with heat.

• Companies are reluctant to invest in preventative measures.

• The lack of resources (or interest) on the part of the labour inspectorate to monitor compliance with current regulations.

• The diminution of the influence and bargaining power of trade unions.

• The business fabric is becoming increasingly fragmented, with a growing number of small companies and self-employed workers.

These circumstances increase the risk of fragmentation and dispersion of OSH systems, endangering the right to health protection for all workers. The size of the company and the sector in which it operates, the existence of previous mobilisation processes on the part of the workers, the strength of the trade union organisations present, the media coverage of occupational accidents linked to heat exposure, the existence of public aid to cover the cost of certain preventive measures, etc. strongly influence the adoption of protective measures by the company. This creates a scenario where workers face significant uncertainty regarding the implementation of heat protection measures, as well as the content of these measures. Collective bargaining and social dialogue could potentially help to address this uncertainty.

All the countries analysed recognise, at least formally, the right of workers to participate in the design, management and implementation of occupational safety and health policies, as well as the positive effects of such participation[28)]. Some countries (the Netherlands being a notable example) have established social dialogue and collective bargaining as a fundamental mechanism for developing and implementing the fundamental protective principles of OSH legislation[4]. The transfer of responsibility for defining the content and principles of OSH regulations in concrete and operational terms to social dialogue would, in theory, make the system more flexible by adapting its

[3] The Wet Bulb Globe Temperature (WBGT) is the most widely used and recognized heat index in occupational settings worldwide. WBGT integrates the effects of humidity, air movement, air temperature, and, in outdoor environments with sunlight, solar radiation. A wide range of commercially available instruments (WBGT meters) can measure heat stress using this index. In addition, several governmental occupational safety agencies have developed their own mobile applications that estimate workplace heat risk. These apps rely on the manual input of various environmental indicators (e.g., air temperature, humidity) to generate a heat index, which can then be used to trigger appropriate preventive or response measures depending on the assessed risk level. For example, in the United States, OSHA and NIOSH have jointly developed the OSHA-NIOSH Heat Safety Tool, while the American Industrial Hygiene Association (AIHA) has created the AIHA Heat Stress App.

[4] Although not as advanced as in the Netherlands, the Spanish case also features institutional mechanisms that facilitate the participation of workers' representatives in the design and implementation of occupational health and safety policies, including those addressing the impact of heat waves. In Spain, companies with more than 50 employees are legally required to establish Health and Safety Committees. These committees are composed of an equal number of representatives from both the workforce and management and are tasked with developing and evaluating prevention plans, identifying risk factors, and proposing preventive measures, among other responsibilities. Decision-making authority, however, ultimately rests with the employer.

content to the specific and changing needs of the different sectors and companies. In other countries, such as Italy, where local authorities are responsible for defining measures to protect the population from heatwaves (including workers), the risk of atomisation of workers' protection has also been addressed through the promotion of (national and sectoral) collective bargaining. In the five countries analysed, social dialogue and collective bargaining should therefore have developed clear mechanisms for protection against heat exposure to compensate for the lack of definition in both public health actions and OSH regulations. However, these objectives have not yet been fully realised.

Firstly, in the majority of the countries analysed, it was noted that trade union representatives have expressed concerns regarding the growing unilateral involvement in OSH matters by companies and governments. Many significant policies and regulatory reforms are implemented without consulting the social partners or without promoting genuine negotiation processes (processes that are not limited to informing workers' representatives about the measures that are going to be implemented). In this respect, the Dutch case would be somewhat different from the other countries analysed because of the greater degree of participation—and greater bargaining power—of workers' representatives. However, some of the reforms implemented in the Netherlands since the 1990s (for example, the removal of specific content from the OSH regulations, the "commoditisation" of the management of companies' OSH services, etc.) have also led to a slight decline in worker participation, as well as to a loss of effectiveness of the OSH system. Nevertheless, the Dutch model still maintains a high degree of worker participation, especially if we compare it with the other countries analysed, where such participation does exist but without clear mechanisms (such as the right of consent of the Dutch works councils) that serve to strengthen the negotiating position of trade union organisations (and in some cases, such as Hungary, with a clear disregard for formally recognised workers' participation rights). It should also be noted that a strong formal position for workers' representatives, such as that enjoyed in the Netherlands, might not always be feasible due to a lack of time, expertise and other resources on the side of the workers.

Secondly, the presence of "heat" in the content of collective bargaining is minimal in the five countries analysed, including those most exposed to heatwaves and the effects of heat exposure. In Spain, for example, of the almost 600 collective agreements (signed between 2020 and 2025) analysed by the Spanish team working on the ADAPTHEAT project, only 2% directly mentioned the term "heat stress", while 31% included some content relating to "heat-related risks". In Greece, of the 24 sectoral collective agreements signed in 2022, only 2 (8%) included measures against heat stress (indeed, sectoral agreements, such as the construction sector, which previously included measures to protect against heat exposure, have seen this content disappear), while in the Netherlands only 3% of the 1,100 collective agreements analysed referred to heat exposure. In Italy and Hungary, the respective national ADAPTHEAT project teams have also noted a very limited mention of heat exposure in traditional collective bargaining[5].

The measures and provisions against heat promoted by traditional collective bargaining, apart from being quite exceptional, have been modest in their scope. In Spain, for instance, the agreements that refer to issues related to heat include very limited proposals for intervention: only 9% of the agreements analysed included preventive clauses that go beyond clothing measures, only 1% included a set of suitable measures for managing the risks associated with high temperatures, and none of them referred to WBGT (see the article on Spain in this special issue of Industrial Health). In Greece, the only two sectoral agreements that make reference to the heat problem set out the possibility of interrupting work at the hottest times. These measures have also been found in some cases reported in Hungary (in the railway sector), as well as in some Italian company agreements (alongside other issues, such as the consideration of heat in risk assessments, the adaptation of PPE or the extension of rest periods). In the Netherlands, a country with a well-established tradition of collective bargaining, the content on heat exposure is also underdeveloped, partly due to a lack of expertise, but also because of the employers' refusal to accept the inclusion of specific measures in agreements that would increase the cost of their production activities. Most collective labour agreements refer to the issue of "workable weather". Some agreements, such as those in agriculture and construction, acknowledge the possibility of stopping work during periods of high heat (for further information, please refer to the article on the Netherlands in this special issue of Industrial Health). In all the above-mentioned cases in the five countries, heat stress risk measurements are usually

[5] It should also be noted that in some of the countries analysed, collective agreement coverage is, in general terms, very low. This is evident in countries such as Hungary and Greece, where the coverage of collective bargaining is approximately 18% and 26% of the employed population, respectively[37].

taken solely on the basis of air temperature.

The challenge of incorporating content beyond the usual collective bargaining topics (wages and working time) into collective labour agreements has prompted social partners to explore alternative instruments in the social dialogue. This has been exemplified in Spain by the adoption of generic action plans against heat by certain companies. In the Netherlands, the government has opted against incorporating "tailor-made legislation" within collective labour agreements, preferring instead to utilise OSH catalogues as a means of implementing EU legislation on safety and health. These catalogues represent a hybrid form of public labour law. In both cases, these are initiatives with positive elements, but also with important limitations.

While we found evidence of collective bargaining and social dialogue addressing the problem of heat exposure in all the countries analysed, we conclude that their presence is still very limited and their content rather meagre. Collective bargaining and social dialogue have not yet led to the concrete implementation or advancement of the generic principles of protection outlined in the OSH regulations of these countries. In all of these cases, we have observed a strong reluctance on the part of companies to incorporate preventive measures against heat because of the economic cost they entail. Given the current lack of interest or resources from governments and labour inspectorates regarding the issue of heat at work, it may be deduced that mobilisation of workers and pressure from trade unions are still key to ensuring that companies adopt preventive measures.

The tendency to decentralise collective bargaining processes and establish non-binding social dialogue agreements is also present, to a greater or lesser extent, in all the countries analysed, generating strong inequalities in the protection of workers depending on the strength of trade union organisations (which is particularly detrimental to the most vulnerable groups). Countries (such as the Netherlands) with a longstanding tradition of worker participation in industrial relations, which still maintain a strong trade union presence and a right of consent for works councils on OSH issues, have been able to somewhat reduce (but not prevent) the damaging effects of these atomising dynamics in Europe. Resilience has been weaker in areas where the trade union fabric has been most affected and collective bargaining has been more decentralised and weakened (as in Greece and Hungary, for example).

Finally, the analysis carried out in this section underlines the importance of having clear and detailed rules and standards of protection that are mandatory for companies. It is essential to establish clear norms and standards that are independent of the balance of power between social partners and their willingness to reach agreements in the social dialogue. However, the experience of the five countries analysed also suggests that the existence of adequate regulations is not a sufficient guarantee of protection if it is not accompanied by the capacity to enforce them effectively. In this regard, it is vital that trade union organisations, the labour inspectorate and other bodies fulfil their monitoring and control roles, as well as the action of these organisations, in order to ensure that workers are adequately protected against heatwaves.

Protection of workers from the risk of heatwaves in the European context

In this section, we present a summary of the various case studies that have been analysed in the five countries participating in the ADAPTHEAT project (refer to section 2 of this article for more information). It is evident that extrapolating the results and findings obtained in the selected case studies is challenging. The value of the case studies lies in their ability to provide a greater degree of detail on the fundamental characteristics or dynamics of the general context in which they are inserted. Despite the development of political and economic integration processes within and outside Europe over the last half century, the regulation of the working world remains largely national in its logic. The "context" of the case studies in question is largely defined within a national framework (in some cases even with a strong regional component) which restricts the possibility of extrapolating the results to other contexts. Despite these methodological limitations, we believe that there are common elements in the selected case studies which, with due caution, can be highlighted. Without prioritising their relevance, the following summarises a number of aspects that have particularly caught our attention.

Firstly, companies are reluctant to incorporate preventive measures against heat exposure that entail an economic cost. From a business perspective, the focus is often on measures that directly impact the company's economic performance, such as enhancing work productivity and reducing absenteeism. While this approach may be understandable from a business perspective, it does not align with the right of workers to maintain their safety and health in the workplace.

Secondly, companies are increasingly opting for voluntary agreements (protocols, action plans) with social partners, preferring to avoid the incorporation of these

provisions in collective agreements (which are obligatory). Companies prefer protocols that allow for some flexibility in their application (e.g. avoiding clearly defined temperature thresholds that could lead to an automatic suspension of activities). In this respect, the case studies analysed have corroborated what had already been anticipated in previous sections of this article: the scarce presence of heat exposure in traditional collective bargaining and the incompleteness of the contents incorporated.

Thirdly, there is a tendency for action plans to prioritise individual preventive measures (hydration, sun cream, adapted PPEs, etc.) over other types of response (e.g. organisational) that are available and often necessary. However, this is a trend that we have observed and not something that occurs in all cases. We have seen instances where companies have accepted the reorganisation of working hours in hot weather, precisely because this type of measure made it possible to increase or maintain work productivity without having to stop work.

Furthermore, the significant challenge of implementing and executing the suspension of work activities as a protective measure in the event of heat exposure is noteworthy. As previously highlighted, defining precise temperature thresholds above which work would be suspended is one of the measures that most frequently proves challenging during collective bargaining negotiations. During the fieldwork, we identified examples of agreements (collective agreements, protocols, action plans, etc.) that incorporate this type of measure in their proposals for protection against heatwaves. However, we cannot confirm their presence in all cases. Furthermore, we have found that, even when work stoppages are formally recognised, they are rarely implemented.

For various reasons, companies and workers (particularly those in more precarious and vulnerable positions) are reluctant to adopt this type of measure. Work stoppage can incur significant economic costs for the company if the legislation obliges workers to continue to receive their wages (in addition to other possible complications such as non-compliance with completion deadlines stipulated in contracts that may lead to financial penalties). In instances where legislation does not guarantee the continuity of remuneration for workers (particularly in cases of irregular employment), the suspension of activity due to heat exposure can result in a loss of income or a systematic reduction in income. If there are no mechanisms in place to prevent the individual employer or worker from bearing the financial cost of implementation, the application of this measure runs the risk of failure (as evidenced by some of the case studies analysed).

We were also able to corroborate another element that we had previously identified: the absence of clear criteria and an agreed methodology for measuring the risk of exposure to heat in each country (and even in each sector). On-site measurements are quite exceptional and most commonly use data from meteorological services based only on air temperature or, at best, also include relative humidity. Many of the approved measures are not up to date or are not aligned with existing scientific evidence, and their application is planned for only the central summer months (when climate change is already clearly anticipating and prolonging the effects of heatwaves to other times of the year).

Furthermore, we have observed a certain tension between the necessity for a clear, precise and well-developed regulatory framework on heat protection (to guarantee the right to protection of all workers and the commitment of companies) and the requirement for the measures contained in the protocols and action plans to have a certain margin of flexibility in their application (to adapt them correctly to the different situations and circumstances present in a company or sector). Addressing both of these factors appears to be a complex undertaking, yet it has been instrumental in ensuring the effective implementation of the preventive measures in place. As previously mentioned in this article and as demonstrated in the analysis of the case studies, the risk of ready-made regulation and the "atomisation" of the regulatory and institutional frameworks of reference is a key concern.

Another key point is the establishment of consolidated spaces for social dialogue, where workers can actively participate, leading to the effective implementation of consensual protection measures against the risks of heat exposure. The development of instruments such as action plans and heat protocols through social dialogue has contributed to improving the protection of workers against heatwaves, despite the limitations of such instruments (the main one probably being their voluntary nature). The willingness of employers to engage in social dialogue is influenced by a number of constantly changing variables (regulatory and institutional pressure, trade union pressure, labour shortages in the sector, company culture, economic developments, competition in the sector, etc.). Making the protection of workers' health dependent on how these variables evolve is risky. In this regard, as previously stated, the translation of these contents into collective agreements is an urgent task that appears to be challenging, given the reluctance of employers in this respect.

Finally, trade union presence and mobilisation has been fundamental for the implementation of heat protection measures, including in those countries with a stronger tradition of social dialogue. While it is not possible to generalise, the fieldwork revealed a high level of non-compliance with regulations by companies. It is vital that workers' representative bodies and the Labour Inspectorate maintain vigilance to ensure that workers are properly protected against the challenges of heat exposure.

Discussion

To a greater or lesser extent, the issue of climate change and its effects is present in the political agenda and actions of the five countries analysed. It is important to note that climate change policies and actions have begun to incorporate other dimensions, such as its impact on health, and are no longer being addressed solely from an environmental perspective. The analysis of the five countries involved in the project shows the incorporation (more or less ambitious depending on the case) of a public health perspective in their approach to climate change.

Climate change is being addressed as a public health issue in all countries, but less so as an occupational health issue. Some agencies responsible for public health are beginning to recognise work as an area requiring specific protection from the effects of climate change, but this recognition has not yet materialised into significant proposals for action. In regard to occupational safety and health (OSH) policies, there is room for improvement in addressing the challenges posed by climate change to workers' health. While all the analysed countries have acknowledged the importance of heat regulation in the workplace, more proactive measures are needed. However, the research demonstrated an enhanced awareness of the consequences of heat exposure on the health of workers.

Despite the existence of these positive developments, the article also identified a number of challenges:

a) Insufficient or incomplete regulatory frameworks in terms of protecting workers from the risks of heat.

b) A lack of reliable and rigorous sources of information that map the impact of heat on workers' health.

c) A wide disparity of heat risk measurement systems in use (some poorly aligned with scientific evidence). Many of these measurement systems are still based mainly on air temperature, and on-site measurements are rare.

d) Many of the prevention measures adopted are only intended for the summer months, even though heatwaves are spreading more and more to other periods of the year. Furthermore, there is a possibility of exposure to heat in certain industries and jobs during the colder months of the year.

e) The application of OSH regulations on protection against heat exposure is not always guaranteed due to various factors, including a lack of awareness among workers and employers, companies' reluctance to implement preventive measures that incur economic costs, limited resources for the labour inspectorate to monitor compliance with current regulations, the weakening of trade union presence and negotiating capacity, the fragmentation of the business sector, and the predominance of small companies and the self-employed.

There is a risk of fragmentation and dispersion of OSH systems, which could endanger the right to health protection for all workers. The size of the company and the sector in which it operates, the existence of previous mobilisation processes on the part of workers, the strength of the trade union organisations involved, the media coverage of occupational accidents linked to heat exposure, the existence of public aid to cover the cost of certain preventive measures, etc. strongly influence the adoption of protective measures by the company. This creates a scenario where workers face significant uncertainty regarding the potential implementation of heat protection measures by employers, as well as the specifics of these measures. Collective bargaining and social dialogue could potentially address this uncertainty.

The right of workers to participate in the design, management and implementation of OSH policies, and the positive effects of such participation, is at least formally recognised in all the countries surveyed. In principle, transferring the responsibility for defining the content and principles of OSH regulations in concrete and operational terms to social dialogue would make the system more flexible by adapting its content to the specific and changing needs of different sectors and companies ("tailor-made regulation"). Social dialogue and collective bargaining should therefore serve to develop clear mechanisms for protection against heat exposure, in order to compensate for the lack of definition in both public health actions and OSH regulations. However, these objectives have not yet been fully realised.

In all the countries analysed, we have noted complaints from trade union players and other workers' representatives regarding unilateral intervention in OSH matters by companies and governments. Many significant policies and regulatory reforms are implemented without consulting the social partners or without promoting genuine negotiation

processes. Companies have also shown a clear preference for voluntary agreements with the social partners, rejecting the incorporation of such content in collective agreements.

The application of basic measures, such as the suspension of work during periods of high heat exposure, is rare. For various reasons, companies and workers (particularly those in more precarious and vulnerable positions) often oppose their implementation. It is not uncommon for companies to be hesitant to implement preventative measures against heat exposure that incur an economic cost. Instead, they tend to prioritise those measures that have a positive impact on the company's economic results, such as ensuring the continuity of work during periods of heat, enhancing work productivity, and reducing absenteeism. The cessation of work can incur an economic cost for the company if the legislation obliges it to maintain wages (in addition to the risk of financial penalties for failure to meet deadlines). From the workers' perspective, when legislation does not guarantee the continuation of wages (or when dealing with workers in an irregular situation), the suspension of work means that their income is stopped (particularly the case with workers hired via a temping agency or bogus self-employed workers). In the absence of mechanisms that prevent the individual employer or worker from bearing the financial cost of their implementation, such as compensation by social security mechanisms or other means to compensate employers, the implementation of this type of measure may be hampered.

The measures and provisions against heat promoted by traditional collective bargaining, apart from being quite exceptional, have been modest in their scope. In this regard, companies tend to prefer protocols that allow for some flexibility in their implementation, such as avoiding clearly defined heat thresholds that could potentially lead to an automatic suspension of activities. The challenge of incorporating content beyond the usual collective bargaining topics (wages and working time) has prompted social partners to explore alternative instruments within social dialogue, such as generic heat action plans and heat protocols. While these initiatives have had positive effects, they have also had important limitations.

The generic heat action plans in Spain have facilitated the establishment of a series of procedures and actions against heat in companies (mostly) on the basis of negotiations with workers' representatives. These procedures have enabled the implementation of more precise action measures, establishing maximum temperature thresholds that trigger different responses. These actions have included both individual and organisational measures. It is important to note that some of these plans have a sectoral application and could serve as a basis for the development of collective agreements with content related to heatwaves. However, the main limitation of these plans lies in their weak implementation, as well as their voluntary nature.

The Dutch OSH catalogues are a set of guidelines established through negotiations between social partners at the sectoral level and endorsed by the Labour Inspectorate. These codes of good practice aim to define specific, clear and coherent protection measures to compensate for the excessive generality of OSH regulations and the risk of fragmentation of workers' safety and health protection systems. However, as with generic action plans, the OSH catalogues also have significant limitations. Firstly, the impact on companies is lower than expected or hoped for. Secondly, the quality of their content is inconsistent, and it is often incomplete or lacking in concreteness. Finally, with regard to the proposed measures, the emphasis is predominantly on individual protection measures, with comparatively less focus on organisational or technical preventive measures. While OSH catalogues can raise awareness of heat risks and establish a negotiation agenda around this issue, they rarely define clear, coherent and detailed preventive or protection measures in practice.

The tendency to decentralise collective bargaining processes and establish non-binding social dialogue agreements is also present, to a greater or lesser extent, in all the countries analysed. This results in significant disparities in the protection of workers, depending on the strength of trade union organisations (which is particularly detrimental to the most vulnerable groups). Countries with a long tradition of worker participation in industrial relations, which still have a strong trade union presence, appear to have been able to reduce (but not prevent) the detrimental effects of these atomising dynamics in Europe. Resilience has been lower in areas where the trade union fabric has been hardest hit and collective bargaining has been more decentralised and weakened.

Examples of collective bargaining and social dialogue addressing the problem of heat exposure were found in all the countries analysed. However, it is evident that their presence remains very limited and their content rather incomplete. Collective bargaining and social dialogue have not yet resulted in the concrete development of the generic principles of protection provided for in OSH regulations. However, positive experiences have been identified where social dialogue has proven to be a useful instrument for the implementation of consensual mechanisms for protection against heat exposure.

Finally, the analysis has confirmed the importance of clear and detailed protection norms and legal standards that are mandatory for companies. Standards and norms that are valid and applicable independently of the balance of power between social partners and their willingness to reach agreements in the social dialogue. Furthermore, the centralisation of legal protection standards would probably result in reduced transaction costs and serve to reinforce the concept of equal legal protection. The implementation of clear legal standards, particularly a science-based occupational exposure limit, would also contribute to legal certainty. However, the experience of the five countries analysed also suggests that the existence of adequate regulations is not a sufficient guarantee of protection if there is no possibility of ensuring that said regulations are effectively applied by companies (which is not always the case). In this regard, it is vital that trade union organisations, the labour inspectorate and other bodies fulfil their monitoring and control roles, as well as the action of these organisations, in order to ensure that workers are properly protected against heatwaves.

Conflict of Interest

None.

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Appendix Table 1.

In-depth interviews conducted during the ADAPTHEAT project

Spain	1 responsible for Occupational Health of the CCOO union
	1 representative of the Ministry of Health
	1 representative of the Labour and Social Security Inspectorate
	1 expert of the Carlos III Health Institute
	1 representative of the National Institute of Safety and Health at Work
	1 representative of the Industry federation of the CCOO union
	4 Occupational Health Advisor/manager of the CCOO union (different sectors)
	1 Legal Representative Workers of the CCOO union
	1 responsible of the Habitat federation of the CCOO union
	TOTAL: 12 key informant interviews
Italy	1 representative from the National Research Council (CNR).
	1 representative from the Institute of Bioeconomy (IBE)
	1 representative from the Worklimate project of the National Institute for Insurance against Accidents at Work (INAIL),
	1 representative from the Department of Medicine and Occupational Epidemiology (DEP Lazio)
	1 representative from the National Heatwave Warning System
	1 representative from the local labour office in Lecce
	2 national and regional representatives of the FLAI-CGIL trade union
	1 representative from the Confagricoltura Apulia employers' union.
	2 national trade union officers from FILT-CGIL
	1 group interview with Workers' Safety Representatives (WSRs) at company, site and territory level.
	TOTAL: 12 key informant interviews
Greece	1 representative from the construction trade union
	1 representative from the ship repair trade union
	1 representative from the delivery trade union
	1 representative from the transport (port) trade union
	1 representative from the GSEE
	1 representative from the Hellenic Federation of Enterprises (SEV)
	1 representative from the Hellenic Confederation of Professionals, Craftsmen and Merchants (GSEVEE)
	1 representative from the employer association Union of Shipbuilding-Ship Repairing of Greece (SENAVI)
	1 representative from the association of Hellenic plastic industries (SVPE),
	3 occupational physicians
	2 safety officers
	2 heat experts
	2 labour inspectors
	TOTAL: 18 key informant interviews
Netherlands	1 representative from STIGAS (sector specialist for greenhouse horticulture)
	1 person from RedStar' Work Council
	1 RedStar's general manager.
	1 expert from Volandis (industry institute)
	2 representatives from the employers' organisation Bouwend Nederland
	2 representatives from the trade union FNV.
	1 person from the Heijmans' Work Council/HSE committee
	1 Heijmans' safety expert and occupational hygienist.
	TOTAL: 10 key informant interviews
Hungary	2 Occupational health and safety experts
	3 trade union representatives
	3 workplace safety experts
	TOTAL: 8 key informant interviews
TOTAL	60 key informant interviews

Source: [28].