CLIMATE CHANGE-RELATED OCCUPATIONAL RISKS IN EUROPE: UNEQUAL IMPACTS ON WORKER SAFETY AND HEALTH

1 Introduction

Climate change poses substantial and unevenly distributed occupational health risks across different groups of workers, geographical areas and sectors in Europe, particularly in cases of extreme heat. Despite this, research at the intersection of climate change and occupational health remains limited (Turner, et al., 2025). Large-scale epidemiological studies demonstrate that heat exposure increases occupational injury risk by 9-17 % during extreme heat events (Fatima, Rothmore, Giles, Varghese, & Bi, 2021; Marinaccio, et al., 2019; Martínez-Solanas, et al., 2018), with an estimated 4,000-5,200 additional injuries per year in Italy alone (Marinaccio, et al., 2019) (Marinaccio, et al., 2025). The annual economic cost varies across European countries, depending on how it is calculated: for example it is EUR 49 million in Italy (it includes compensation costs only) (Marinaccio, et al., 2025) and EUR 370 million in Spain (this figure includes several cost drivers) (Martínez-Solanas, et al., 2018) The north-south gradient in heat exposure within Europe means that workers in southern Europe face the most immediate risks, but climate projections indicate that occupational heat stress will increasingly affect central and northern regions of Europe (Casanueva, et al., 2020; Morabito, et al., 2019).

Despite these emerging risks, evidence on occupational safety and health (OSH) in the context of climate change remains limited, particularly from a cross-national comparative perspective. Much of the existing research is based on single-country studies or specific sectors, making it difficult to assess how climate-change related occupational risks vary across the European workforce as a whole. To address this gap, the 2025 OSH Pulse Worker survey collected data from a representative sample of around 28,000 workers across 30 European countries (EU-OSHA, 2025). The survey examined three key areas: exposure to climate change-related risk factors, concerns about their impact on OSH, and workplace measures implemented to address climate-change related risks. This provides a unique cross-national perspective on how climate change is affecting working conditions, as well as how workplaces are responding.

The 2025 OSH Pulse survey indicated that 33 % of workers across the EU reported exposure to at least one climate change-related risk factor at work (EU-OSHA, 2025). The most commonly reported exposures are extreme heat (20 %) and air quality issues, such as dust, smoke, or pollen (19 %), followed by intense sun exposure (12 %) and extreme weather events (9 %), including floods, wildfires and droughts (EU-OSHA, 2025). Around one third of workers (31 %) believed that climate change-related issues may negatively affect their safety and health at work, while 18 % reported concerns about changes to their job or tasks due to climate-change related preventive measures.

Reported health outcomes directly linked to climate-change related exposures are relatively low in comparison to other work-related health problems. In the past 12 months, 7 % of workers reported heat-related symptoms or illnesses such as dizziness, cramps, exhaustion or heat stroke, and 3 % reported sunburn (EU-OSHA, 2025). By contrast, much higher proportions reported fatigue (37 %), headaches or eyestrain (35 %), and stress, depression or anxiety (29 %), not necessarily related to climate-change related hazards. This suggests that the health impacts of climate-change related exposures may overlap with broader occupational health problems, or may not always be recognised as climate-change related.

There are also gaps in awareness and implementation of workplace responses to climate-change related risks. While 58 % of workers reported organisational measures such as flexible working hours, additional breaks, or job rotation to reduce heat stress, and 54 % reported technical measures such as cooling systems or climate-adapted personal protective equipment (EU-OSHA, 2025), only 30 %

reported receiving information or training on managing climate-change related risks. In addition, just 25 % reported being consulted about climate change-related occupational health concerns.

Although these findings show that climate change is already affecting a substantial percentage of workers across Europe, overall statistics may mask important differences across social and occupational groups. Certain workers may face higher exposure to climate hazards, greater vulnerability to their health effects, or more limited access to preventive measures. Understanding these inequalities is therefore essential for identifying vulnerable groups and informing targeted OSH policies and workplace adaptation strategies. The objectives of this discussion paper are therefore to:

1. Review the literature on inequalities in OSH in relation to climate change to identify research gaps and factors of interest to inform subsequent analysis.
2. Explore inequalities in OSH in relation to climate change within the 2025 OSH Pulse survey.

The remainder of this paper is structured as follows: Section 2 reviews the existing literature on climate change and OSH, summarising evidence on the effects of climate change on OSH outcomes, the unequal impacts on different social groups, and key research gaps that the present study aims at filling. Section 3 sets out the research questions addressed by the subsequent analysis. Section 4 describes the methodology, including details of the 2025 OSH Pulse survey data, the key variables examined, the statistical approach used, and a description of the sample. Section 5 presents the results, covering exposure to climate-change related hazards, climate-change related physical and mental health outcomes, the availability of preventive measures, and an intersectional analysis across social groups. Section 6 discusses the implications of these findings for OSH policy and practice, the strengths and limitations of the research, and priorities for future research and policy. Section 7 concludes the paper, and Section 8 provides the full list of references cited. A technical appendix can also be found at the end of the paper.

2 Climate change and OSH: evidence from the literature

To assist in developing the specific research questions for this study, a rapid review[1] of the literature was conducted. The rapid review aimed to identify the current state of evidence, highlight key findings, and pinpoint gaps in the literature that this study aims to fill. Using the Elicit[2] systematic review software (Bernard, et al., 2025; Whitfield & Hofmann, 2023), we searched Semantic Scholar and OpenAlex during February 2026 for relevant studies addressing the implications of climate change for workplace health and safety, particularly for different social and occupational groups in Europe.[3] This was complemented by a Google Scholar search and the authors' own knowledge of relevant literature. We limited searches to the past 25 years (from the year 2000 onwards).

The search using Elicit identified 24 papers. The studies identified were dominated by countries in southern Europe (Italy, Spain and Greece), which tended to explore heat as their key exposure at work, with fewer investigations from central, northern and western Europe. Study types ranged from large-scale epidemiological analyses with millions of injury records to small qualitative investigations with a handful of interviews. The sectoral focus is heavily concentrated on agriculture and construction, with manufacturing, logistics and fisheries receiving more limited attention. Other sectors were unrepresented. The following sections summarise the main strands of evidence emerging from this literature, focusing on occupational injuries, worker health outcomes, productivity impacts and social inequalities.

2.1 Effects of climate change on OSH

2.1.1 Occupational injuries

The epidemiological evidence consistently demonstrates a relationship between extreme temperatures (e.g. workplace environmental temperatures that are sufficiently high – or low – to create a potential health or safety risk for workers, especially when exposure is prolonged or combined with physical exertion) and increased occupational injuries in Europe. The largest studies come from Italy and Spain, and they provide some of the most robust quantitative evidence on the occupational health consequences of climate change. A study by Marinaccio et al. (2019) found that extreme temperatures increased the risk of workplace injuries, with injuries around 17 % more likely during hot conditions and 23 % more likely during cold conditions, resulting in an estimated 5,211 additional injuries each year in Italy. A subsequent Italian study from 2014-2019 estimated that 25,632 occupational injuries were attributable to heat exposure over that period, averaging 4,272 cases per year (Marinaccio, et al., 2025). In Spain, Martínez-Solanas et al. (2018) found that 2.72 % of all 15,992,310 occupational injuries during 1994-2013 were attributable to non-optimal ambient temperatures, with a 9 % increase in injury risk from extreme heat and a 4 % increase related to extreme cold. In Switzerland, Drescher & Janzen (2025) reported a 7.4 % increase in occupational accidents on hot days ($T_{max} \geq 30$ °C) and a 6.3 % increase on very cold days ($T_{max} < 0$ °C), amounting to approximately 2,600 additional workplace accidents per year.

A meta-analysis by Fatima et al. (2021) pooled results from 22 studies across 6 countries and estimated a 1 % increase in occupational injury risk for every 1 °C increase in temperature above reference values, and a 17.4 % increase during heatwave periods. The risk varied by climate zone, with the highest risk during hot temperatures found in humid subtropical climates (2 % increase), followed by oceanic (1 % increase) and hot Mediterranean climates (0.9 % increase). Together, these findings

[1] The main differences between a rapid systematic review and a systematic review are speed and scope, as a rapid systematic review uses an abbreviated version of the methods of a conventional systematic review to produce evidence more quickly. This may involve a higher bias but was considered appropriate for the aim and scope of this study.

[2] Elicit has shown promise as a complementary tool rather than a standalone replacement for traditional systematic review methods (Bernard, et al., 2025) (Hilkenmeier, Pelzer, Stierle, & Fink-Lamotte, 2025) (Lau & Golder, 2025). For literature searches, Elicit's high level of precision makes it valuable for scoping searches. For data extraction, Elicit performs comparably to human reviewers, achieving 81.4 % accuracy versus 86.7 % for humans (Hilkenmeier, Pelzer, Stierle, & Fink-Lamotte, 2025) and has been used within published systematic reviews in this area (Niedzwiedz, Kankawale, & Katikireddi, 2025).

[3] Search terms included ('occupational health' OR 'workplace health' OR 'worker health' OR 'occupational health and safety') AND ('climate change' OR 'global warming' OR 'extreme heat' OR 'heat stress' OR 'temperature extremes') AND (Europe OR European) AND ('occupational groups' OR 'social groups' OR workers OR employees OR 'vulnerable populations' OR 'vulnerable groups'). A total of 1,000 abstracts were evaluated within Elicit (limited by the software) and 24 were included (scoring 4 or more according to whether they met criteria relating to Population (European working population), Exposure (climate change-related impacts like extreme heat), Comparator (different social or occupational groupings), or Outcome (work-related health outcome such as heat-related illness, productivity changes, injuries, etc.).

demonstrate that both high and low temperatures can increase the likelihood of workplace accidents, highlighting temperature as an important occupational risk factor.

2.1.2 Worker health and symptoms

Beyond injuries, the literature documents a spectrum of direct health effects. These health outcomes reflect both acute heat-related illness and longer-term health risks associated with occupational heat exposure. Pogačar et al. (2018) found that 96 % of 400 manufacturing workers surveyed in Slovenia perceived temperature conditions as unsuitable and 56 % experienced headaches and fatigue during summer. Morris (2021) identified evidence for cardiovascular disease, respiratory problems, chronic kidney disease and mental health issues (depression, anxiety) in heat-exposed workers, and Levi, Kjellstrom and Baldasseroni (2018) highlighted evidence for heat-related illness and the expanding habitat of disease vectors (such as mosquitos and ticks) affecting outdoor workers. Though primarily documented outside Europe, Mesoamerican nephropathy (a type of non-diabetic, non-hypertensive chronic kidney disease (CKD)), commonly seen in outdoor workers (particularly sugarcane workers) living in rural areas with a hot and humid climate (Sanchez Polo, Garcia-Trabanino, Rodriguez, & Madero, 2020), was also flagged as a potential concern for workers in physically demanding, heat-exposed occupations (Levi, Kjellstrom, & Baldasseroni, 2018; Makembi Bunkete, 2026), with increasing temperatures potentially recreating the environmental conditions seen in tropical regions (Makembi Bunkete, 2026). Other studies also document impacts on kidney function among agricultural workers in Spain after only one shift (Koch, et al., 2025). This suggests that the health impacts of climate change on workers extend beyond injuries to include a wider range of physiological and psychological effects.

2.1.3 Productivity loss and economic costs

In addition to affecting workers’ health, climate-change related heat exposure can have significant economic consequences for employers and national economies, and evidence indicates substantial present and future productivity losses. Casanueva et al. (2020) emphasised that future heat exposure in large parts of Europe will exceed critical levels for physically active workers far more frequently, while De Sario et al. (2023) found actual global productivity losses of nearly 10 %, losses that are expected to rise to 30-40% under worst-case scenarios by the end of century. Marinaccio et al. (2025) estimated a productivity decrease of approximately 6.5 % for workers performing high metabolic rate activities for every 1 °C increase between 19.6 °C and 31.8 °C. In economic terms, Martínez-Solanas et al. (2018) estimated the annual cost in Spain at EUR 370 million (0.03 % of GDP) relating to occupational injuries only, corresponding to 0.67 million person-days of work lost per year, while Marinaccio et al. (2025) placed Italian compensation costs at over EUR 292 million for 2014-2019 (~EUR 49 million/year), and Drescher et al. (2025) estimated this at CHF 91 million annually relating to occupational injuries in Switzerland. These estimates highlight the potential scale of economic disruption if occupational heat exposure continues to intensify under climate change.

2.2 Unequal impacts on social groups

A central concern of this review is the extent to which the evidence base addresses differential impacts of climate change-related OSH risks and outcomes across social groups. The findings reveal that while some dimensions of inequality have been examined, substantial gaps remain. Existing studies suggest that climate-change related occupational risks are not evenly distributed across the workforce but are influenced by a combination of demographic, social and employment-related characteristics. Understanding these differences is essential for identifying possible inequalities, vulnerable worker groups and designing targeted OSH interventions. The literature identifies several key dimensions of inequality, including gender, migration status, age and socio-economic and employment characteristics potentially affecting climate-change related occupational health risk. However, the depth and consistency of evidence vary considerably across these dimensions.

2.2.1 Gender

Gender differences in heat-related occupational outcomes were examined in several studies, though findings were somewhat inconsistent. In the Italian epidemiological studies, the risk of heat-related injuries was found to increase by around 14 % for men, compared to around 5 % for women (Marinaccio, et al., 2025), and that male workers were also found to be more vulnerable to heat, while female workers were more vulnerable to cold (Marinaccio, et al., 2019). Martínez-Solanas et al. (2018) similarly found women to be more vulnerable to cold and men more vulnerable to heat in Spain. Meanwhile, Pogačar et al. (2018) reported that women in a Slovenian manufacturing plant were more sensitive to hot conditions and reported more heat-related symptoms, and Morris et al. (2021) noted that women may be at greater risk of dehydration due to fears of appearing weak and having fewer rest breaks. In contrast, Drescher & Janzen (2025) found no significant differences in the impact of hot days on workplace accidents across genders in Switzerland. Several studies, including a comparative European analysis by Riesco-Sanz (2026), a Hungarian study by Tóth (2026), and an EU fisheries analysis by Alsaleh, Xia & Abdul-Rahim (2025) did not examine gender differences. These mixed findings suggest that gender inequalities may partly reflect occupational segregation, with men more frequently employed in outdoor or physically demanding occupations, while women may experience different forms of vulnerability within indoor or service sector environments. The limited exploration of gender across studies indicates that gender-sensitive analyses remain underdeveloped within the climate and occupational health literature.

2.2.2 Migration status

Migration status may also be a critical but understudied dimension. Messeri et al. (2019) found that migrant workers in Italian agriculture and construction reported that work required greater effort than non-migrant workers, but paradoxically reported less impact from heat on productivity and less thermal discomfort, potentially reflecting cultural differences in risk perception, social desirability bias, or differences in willingness to accept higher thermal discomfort. Errico & Di Nunzio (2026) identified migrant workers in Apulian agriculture and logistics industries as disproportionately affected, particularly those in smaller firms without trade union representation. Salas-Nicás & Laabbas-El-Guennouni (2026) identified newly arrived migrants as particularly exposed, alongside informal and precarious workers. De Sario et al. (2023) highlighted migrant agricultural workers as particularly vulnerable due to their working conditions, while Fatima et al. (2021) highlighted language barriers, extended work hours, and limited safety training as important factors. Morris et al. (2020) noted that migrant workers expressed more satisfaction with workplace measures due to previous negative experiences in home countries. The Swiss study by Drescher & Janzen (2025) included nationality as a variable, but found no significant differential effect of hot days across nationality groups. Overall, the evidence on migration-related inequalities remains limited and fragmented, highlighting the need for more systematic analyses of migrant worker exposure and vulnerability.

2.2.3 Age

Age-related vulnerability was one of the more consistently studied dimensions. Young workers (aged under 35) were found to be at a higher risk of heat-related injuries in Italy (Marinaccio, et al., 2019) (Marinaccio, et al., 2025), Spain (Martínez-Solanas, et al., 2018), and in pooled meta-analysis (Fatima, Rothmore, Giles, Varghese, & Bi, 2021). This pattern may reflect the concentration of young workers in physically demanding outdoor roles, as well as relative inexperience. Conversely, older workers showed higher vulnerability to cold temperatures (Marinaccio, et al., 2019; Martínez-Solanas, et al., 2018) and were identified as a high-risk group for heat effects due to chronic health conditions (Morris, et al., 2021; Tóth, 2026). Morris et al. (2020) noted that both younger and older workers were at elevated risk. Taken together, these findings suggest that age-related vulnerability may operate through different mechanisms, including job type, work experience, and underlying health conditions. No studies examined age in combination with other characteristics, such as gender and migration status.

2.2.4 Socio-economic status and employment characteristics

Socio-economic status and employment conditions are also important determinants of workers' exposure and vulnerability to climate-change related occupational risks. Within the literature, workers in small and medium-sized firms faced higher heat-related injury risks in Italy (Marinaccio, et al., 2019), and several qualitative studies emphasised that workers in companies with weak union presence received less protection (Riesco-Sanz, 2026; Errico & Di Nunzio, 2026; Salas-Nicás & Laabbas-El-Guennouni, 2026). Morris et al. (2021) highlighted that piece-rate pay systems could exacerbate heat exposure by discouraging rest breaks. Notably, informal workers were explicitly excluded from the two largest epidemiological studies (Marinaccio, et al., 2019; Martínez-Solanas, et al., 2018), representing a significant evidence gap, given that informal workers likely face the worst working conditions. Paterson & Godsmark (2020) identified socio-economically disadvantaged and urban dwellers in Ireland as particularly vulnerable. Overall, the available evidence indicates that socio-economic disadvantage, precarious employment, and weaker workplace protections may compound the occupational risks associated with climate change including the heat-related ones.

2.3 Key gaps in the literature

2.3.1 Understudied health outcomes

There is a major gap in studies on climate change-related mental health outcomes in the occupational health literature (Brooks & Greenberg, 2023). Despite increasing recognition that climate change can affect psychological well-being (Niedzwiedz, et al., 2025), very few studies have examined mental health outcomes among workers exposed to climate change-related hazards. While Morris et al. (2021) listed depression and anxiety among heat-related occupational health effects and Paterson & Godsmark (2020) noted mental health as a relevant outcome, no included study provided primary quantitative data on the mental health effects of climate change among European workers. Notably, Levi, Kjellstrom, & Baldasseroni (2018) explicitly acknowledged that mental health problems were not comprehensively assessed in their systematic review. This suggests that, despite growing awareness of the psychological impacts of climate change, the occupational health literature has largely focused on physical health outcomes such as injuries and heat-related illnesses.

Eco-anxiety, however, is increasingly recognised as an emerging and relevant OSH outcome across Europe (EU-OSHA, 2025). Eco-anxiety refers to psychological distress and concern linked to climate change and environmental degradation (Niedzwiedz, et al., 2025). It may manifest in the workplace as anxiety about future climate impacts, concerns over job security or meaningful work, and stress related to climate-change related risks at work. Some preliminary evidence suggests that climate anxiety is rising among certain occupational groups in Europe, particularly in the education and energy sectors (Lam, Demou, & Ho, 2026). The lack of quantitative evidence represents a significant gap in the literature and highlights the need for further research examining mental health outcomes. As a result, the mental health dimension of climate change-related occupational risks remains insufficiently understood.

2.3.2 Understudied exposures

Most studies have examined high ambient outdoor temperatures at work, with indoor heat exposure representing a critical gap. Both large Italian epidemiological studies included used ambient outdoor temperatures and acknowledged this as a limitation (Marinaccio, et al., 2019; Marinaccio, et al., 2025). This reliance on outdoor temperature measures means that occupational heat exposure among indoor workers may be substantially underestimated in current research. A recent study, which examined 117,675 participants from the UK Biobank, looked at the association between long-term exposure to workplace environmental hazards and mental health, and suggested a dose-response relationship with mental health according to exposure to very hot workplaces. Subgroup analysis by sex found that the associations between very hot/cold environments and mental health were stronger in females (Lam, Demou, & Ho, 2026). The effectiveness of specific cooling interventions and work schedule modifications also remains poorly evaluated. Morris et al. (2020) reported that only 30 % of respondents who were aware of cooling strategies at their workplace considered them effective. This suggests that although preventive measures may exist in some workplaces, their implementation and effectiveness are not yet well understood. The combined effects of heat with air pollution, wildfires and drought were also identified as a significant gap by Mazzalai et al. (2023). Understanding these combined environmental exposures is particularly important because workers may simultaneously experience multiple climate change-related hazards that interact to amplify health risks.

2.3.3 Understudied groups of workers

Informal and precarious workers are systematically excluded from the evidence base. The two largest epidemiological datasets (covering Italy and Spain) excluded informal workers due to reliance on compensation claims (Marinaccio, et al., 2019; Martínez-Solanas, et al., 2018). Migrant workers, while identified as vulnerable in multiple qualitative studies (De Sario, et al., 2023) (Messeri, et al., 2019) (Errico & Di Nunzio, 2026), lack systematic quantitative evidence regarding their differential risk. Messeri et al. (2019) provided the only primary survey data comparing non-migrant and migrant worker heat stress perceptions, but with a small (n=104) and unbalanced sample (63 % non-migrant). This highlights the need for large-scale quantitative studies capable of examining climate change-related occupational risks across diverse worker populations. Workers with pre-existing chronic conditions were flagged as an understudied group by Levi, Kjellstrom, & Baldasseroni (2018) and Morabito et al. (2019), who noted the complexity of personalising heat risk for workers with pre-existing conditions or taking specific medications. Despite this recognition, empirical research examining how underlying health conditions interact with occupational climate exposures remains very limited.

2.3.4 Geographic and sectoral gaps

The geographic concentration of epidemiological evidence in Mediterranean countries (Italy, Spain, Greece) and a single temperate climate study in Switzerland leaves large parts of Europe unexamined. This geographic imbalance limits the generalisability of existing findings and makes it difficult to assess how climate-change related occupational risks may differ across Europe's diverse climatic regions. Sectoral coverage is similarly uneven. Agriculture and construction dominate the literature (Pogačar, et al., 2018; Tóth, 2026), while indoor-exposed sectors such as logistics, food processing and manufacturing receive more limited attention despite documented non-optimal thermal conditions (Riesco-Sanz, 2026; Paterson & Godsmark, 2020). This sectoral bias reflects the traditional focus on outdoor work, but overlooks the growing number of workers exposed to heat and environmental hazards within indoor workplaces.

2.4 Summary

The literature reviewed above demonstrates that climate change is already affecting OSH across Europe through increased risks of injuries, adverse health outcomes and productivity losses. At the same time, the evidence indicates that these impacts are unevenly distributed across the workforce, with certain social and occupational groups potentially facing greater exposure and vulnerability. However, existing studies are typically limited to single countries, specific sectors, or individual dimensions of inequality, making it difficult to understand how these risks are distributed across the broader European workforce. Furthermore, relatively little research has examined how exposure to climate change-related hazards, associated health outcomes, and the availability of workplace preventive measures vary and interact across different groups of workers. This study addresses these gaps by analysing cross-national survey data from workers across 30 European countries as part of the 2025 OSH Pulse survey.

3 Definition of Research Questions (RQs)

Building on the literature reviewed above, this study aims to address several key gaps relating to differential exposure, vulnerability and workplace preventive measures for climate-change related occupational risks across Europe. The research questions that will guide this study are illustrated below.

RQ1 – Differential exposure

How does exposure to climate-related hazards (e.g. extreme heat) in the workplace vary across social and occupational (i.e. job type, sector, indoor/outdoor worker) groups of workers across Europe?

RQ2 – Differential vulnerability

How do physical and mental health outcomes associated with climate-related occupational exposures differ across social and occupational groups?

RQ3 – Differential availability of preventive measures

How do climate-related preventive measures within the workplace (including access to information and training, work organisation adjustments, worker consultation and protective measures) vary across social and occupational groups?

RQ4 – Intersectional inequalities

Which combinations of social and occupational characteristics carry the highest and lowest risk of adverse climate-related health outcomes?

4 Methodology

4.1 Data source

The data source used in this study is the 2025 OSH Pulse survey. On behalf of EU-OSHA, Ipsos European Public Affairs conducted interviews with a representative sample of employed individuals (employees and self-employed workers), aged 16 years and over, in each of the 27 EU Member States, as well as in Iceland and Norway (EU-OSHA, 2025). Fieldwork was carried out between 31 March and 14 April 2025, during which 28,220 telephone interviews (via mobile phones) were completed. In Switzerland, a separate representative sample of employed workers was surveyed between 2 and 7 April 2025 using computer-assisted web interviewing (CAWI), drawing on Ipsos online panels and partner networks. Please refer to European Agency for Safety and Health at Work (2025) for full methodological details of the survey. The survey provides harmonised cross-national data on workers' exposure to climate change-related occupational hazards, associated health outcomes, and workplace adaptation measures across 30 European countries, as well as other OSH issues.

4.2 Key variables examined

The selection of climate-change related exposures, health outcomes and workplace preventive measures was guided by the above literature review on climate-change related occupational health risks and by the structure and sample of the 2025 OSH Pulse survey.

Climate change-related workplace exposures such as extreme heat, sun exposure, air quality issues and extreme weather events represent key environmental hazards that are expected to increase in frequency and intensity as a result of climate change. These exposures have been linked in previous studies to occupational injuries, heat-related illness and reduced worker well-being, as mentioned above in Section 2.1.

The outcome measures were chosen to capture both direct physical health effects, such as heat-related symptoms and sunburn, as well as mental health/well-being outcomes relating to the perceptions of climate-change related risk to safety and health at work, which may reflect broader concerns about workplace vulnerability to climate change. In addition, indicators of workplace preventive measures, including training, organisational adjustments, consultation and technical protections, were included to assess how workplaces are responding to climate-change related risks.

Together, these measures allowed the examination not only of differential exposure and health vulnerability, but also potential inequalities in access to workplace adaptation and preventive measures. Box 1 summarises the key variables examined according to the research questions.

Box 1: Research questions and related outcome variables

Research questions and related outcome variables

1 RQ1 · Exposure

How does exposure to climate-related hazards in the workplace vary across sociodemographic and occupational groups?

Outcome variables

- Extreme heat (indoor/outdoor)
- Intense sun exposure
- Air quality issues (pollen, dust, smoke)
- Extreme weather events (floods, wildfires, etc.)

2 RQ2 · Health outcomes

How do physical and mental health outcomes related to climate-related occupational exposures differ across sociodemographic and occupational groups?

Outcome variables

Physical health
- Heat-related illness (dizziness, exhaustion, stroke)
- Sunburn

Mental health & wellbeing
- Worry about climate impact on safety/health at work
- Fear of job/task changes due to preventive measures

3 RQ3 · Preventive measures

How do preventive measures for climate-related risks within the workplace vary across sociodemographic and occupational groups?

Outcome variables

- Information & training on handling climate risks
- Work organisation adjustments (flexible time, breaks)
- Consultation of workers on climate concerns
- Protective measures (insulation, cooling, PPE)

4 RQ4 · Intersectional inequalities

Which combinations of sociodemographic and occupational characteristics carry the highest and lowest risk of adverse climate-related outcomes?

Outcome variables

- Exposure to extreme heat
- Heat-related illness
- Worry about OSH

4.2.1 Sociodemographic and occupational variables

The selection of social and occupational variables was informed by existing evidence on inequalities in occupational health and by the intersectional analytical framework adopted in this study. Sociodemographic characteristics such as gender, age, education and migration status were included because previous research suggests that exposure to climate-change related occupational risks may vary across different population groups, due to differences in labour market position and working conditions. Occupational characteristics including sector (classified according to a collapsed version of NACE Rev. 2), occupation, work setting (indoor or outdoor) and employment contract were also included, to capture differences in workplace environments and job tasks that may influence exposure to climate-change related hazards and access to preventive measures. Together, these variables allowed the analysis to examine how combinations of sociodemographic and occupational characteristics shape workers' exposure to climate-change related risks, their vulnerability to associated health outcomes, and their access to workplace protections. Box 2 displays the sociodemographic and occupational variables selected for the analysis.

Box 2: Sociodemographic and occupational variables included in the analysis

Sociodemographic and occupational variables included in the analysis

Sociodemographic	
Gender	Male; Female
Age group	16-24 · 25-39 · 40-54 · 55+ years
Education	Low: left education at ≤15 years Medium: left at 16-19 years High: left at 20+ years
Migration	Non-migrant: born in country of residence Migrant: not born in country of residence

Occupational	
Sector / Industry	1. Administration and support services 2. Agriculture, horticulture, forestry or fishing 3. Gas, electricity or water supply 4. Mining or quarrying 5. Manufacturing or engineering 6. Construction or building 7. Commerce, transport, accommodation or food services 8. Information and communication technology 9. Finance 10. Professional, scientific or technical services 11. Education services 12. Health or social care services 13. Social, cultural, personal and other services
Occupation	9 categories: professional/technical, higher admin, clerical, sales, service, skilled, semi-skilled, unskilled, farm worker
Setting	Indoor: employer/client premises, vehicles, home, public spaces Outdoor: outside work sites
Employment Contract	Self-employed Employee with a permanent contract Employee with a temporary contract

4.3 Statistical analysis

The analysis proceeded in two complementary stages. The first applied a traditional multilevel framework, nesting individuals within countries to estimate how sociodemographic and occupational characteristics related to each outcome, adjusting for relevant covariates. This was implemented through two-level mixed-effects logistic regression, with individuals at level one and countries at level two, using random effects at country level to account for the clustering of survey respondents within nations. For every outcome, both unadjusted models (examining each predictor on its own) and adjusted models (controlling jointly for age, gender, education, migrant status, outdoor work, occupation type, industry sector and employment contract) were estimated, with results reported as predicted probabilities and 95 % confidence intervals derived from post-estimation margins.

The second stage moved beyond single-axis comparisons to an intersectional approach, recognising that adverse climate-change related outcomes often arise from the combination of occupational and social characteristics rather than any one factor alone. This was achieved through Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (MAIHDA) (Evans, Leckie, Subramanian, Bell, & Merlo, 2024; Evans, Leckie, Subramanian, Bell, & Merlo, 2024) (Evans, Williams, Onnela, & Subramanian, 2018), which captures both individual-level effects and group-level heterogeneity without requiring an unwieldy set of interaction terms. The model structure comprised three levels: individuals nested within intersectional strata, which are, in turn, nested within countries. Strata are treated as country-specific so that the same combination of characteristics in two countries constitutes two distinct groups, each shaped by its national labour market, climatic and regulatory context.

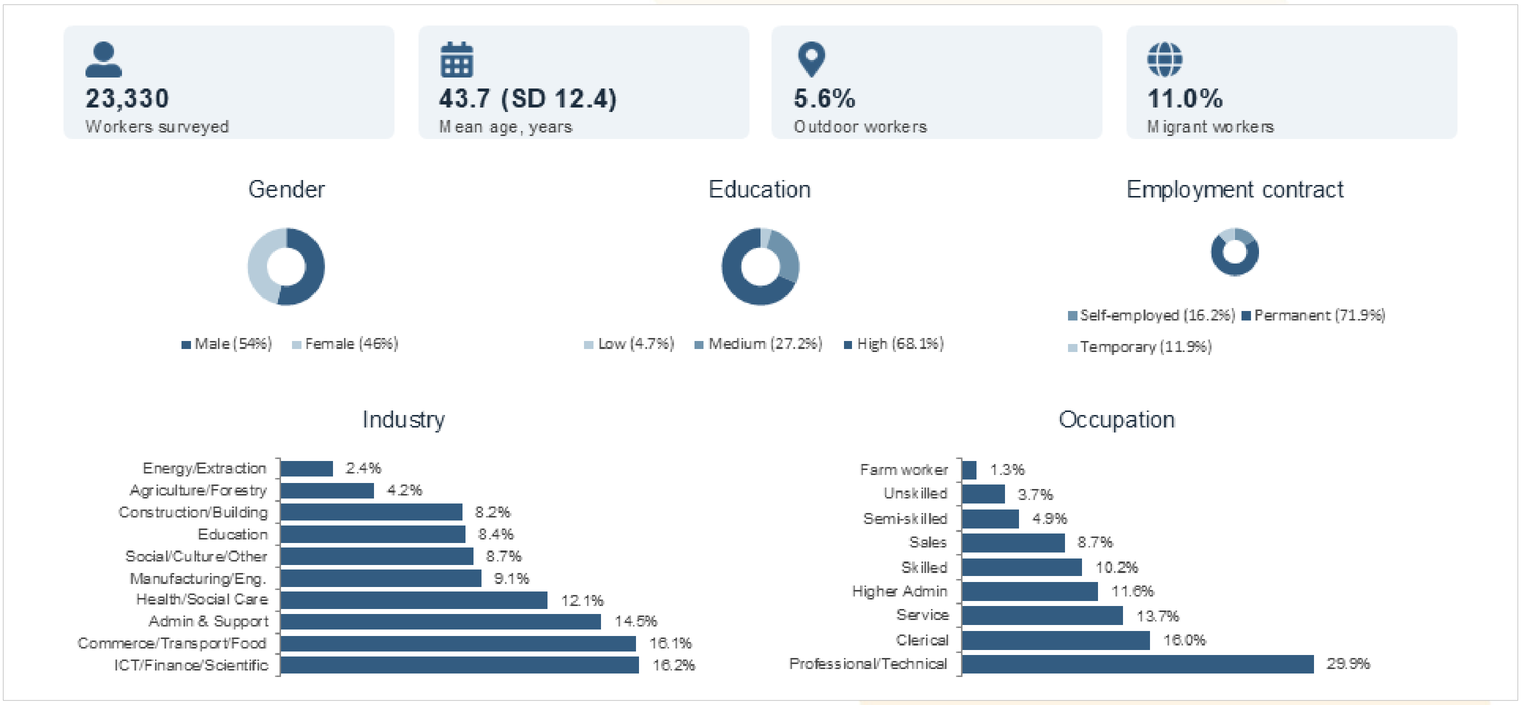
Based on the first-stage exploratory analysis, strata were defined by four characteristics: occupational group (white-collar, comprising professional, administrative, clerical and sales occupations; service; skilled manual; and semi-/unskilled manual, including farm workers), education (higher versus lower/medium), migration status and gender, yielding 32 possible profiles (4x2x2x2). Sparse strata were retained in all models rather than excluded, and their estimates were stabilised through precision-weighting, which shrinks unreliable estimates towards the country average in proportion to their imprecision.

A separate MAIHDA model was fitted for each of the three selected outcomes (exposure to extreme heat, heat-related illness, and concerns about the OSH impacts of climate change). Modelling proceeded in two steps: a null, variance components model estimating the extent to which each outcome varied across intersectional strata and across countries, followed by a main effects model adding the additive contributions of the four stratum-defining variables plus age group, retaining random intercepts for strata and country. The variance partition coefficient (VPC) quantified the share of total variation attributable to intersectional group membership and to country. The proportional change in stratum-level variance between the two models (PCV) indicated how far additive effects account for between-strata differences; any remaining stratum variance reflected excess or reduced risk specific to particular combinations of characteristics. Stratum-level predicted probabilities identify the combinations facing disproportionate risk, with strata with fewer than 10 respondents excluded from figure rankings but retained in model estimation. As a sensitivity analysis, all models were re-estimated excluding strata with fewer than 10 respondents.

Across both analysis stages, the analysis was restricted to respondents with valid responses on key outcome and stratification variables, excluding those who answered 'don't know' or 'prefer not to say'. Survey weights were applied to models as part of the first analysis stage (the intersectional models were unweighted), which correct for deviations in the age, gender and regional distributions, adjusted for the population size of each country. Claude (Anthropic) was used to assist in developing the Stata analysis and visualisation code; all analyses and graphs were produced in StataNow MP 19.5.

4.4 Description of the sample

Box 3: Summary of the pooled sample across 30 countries (weighted)



A total of 23,330 individuals were included in the analysis sample across the 30 countries (see Box 3 for a summary of the pooled sample). Participants had a mean age of 43.7 years (SD 12.4), with country-specific means ranging from 40.1 years in Malta to 45.3 years in Bulgaria and Italy. The sample comprised 54.0 % male and 46.0 % female workers, with educational attainment distributed as follows: 4.7 % low, 27.2 % medium, and 68.1 % high levels of education. Migrant workers represented 11.0 % of the sample, while outdoor workers accounted for 5.6 %.

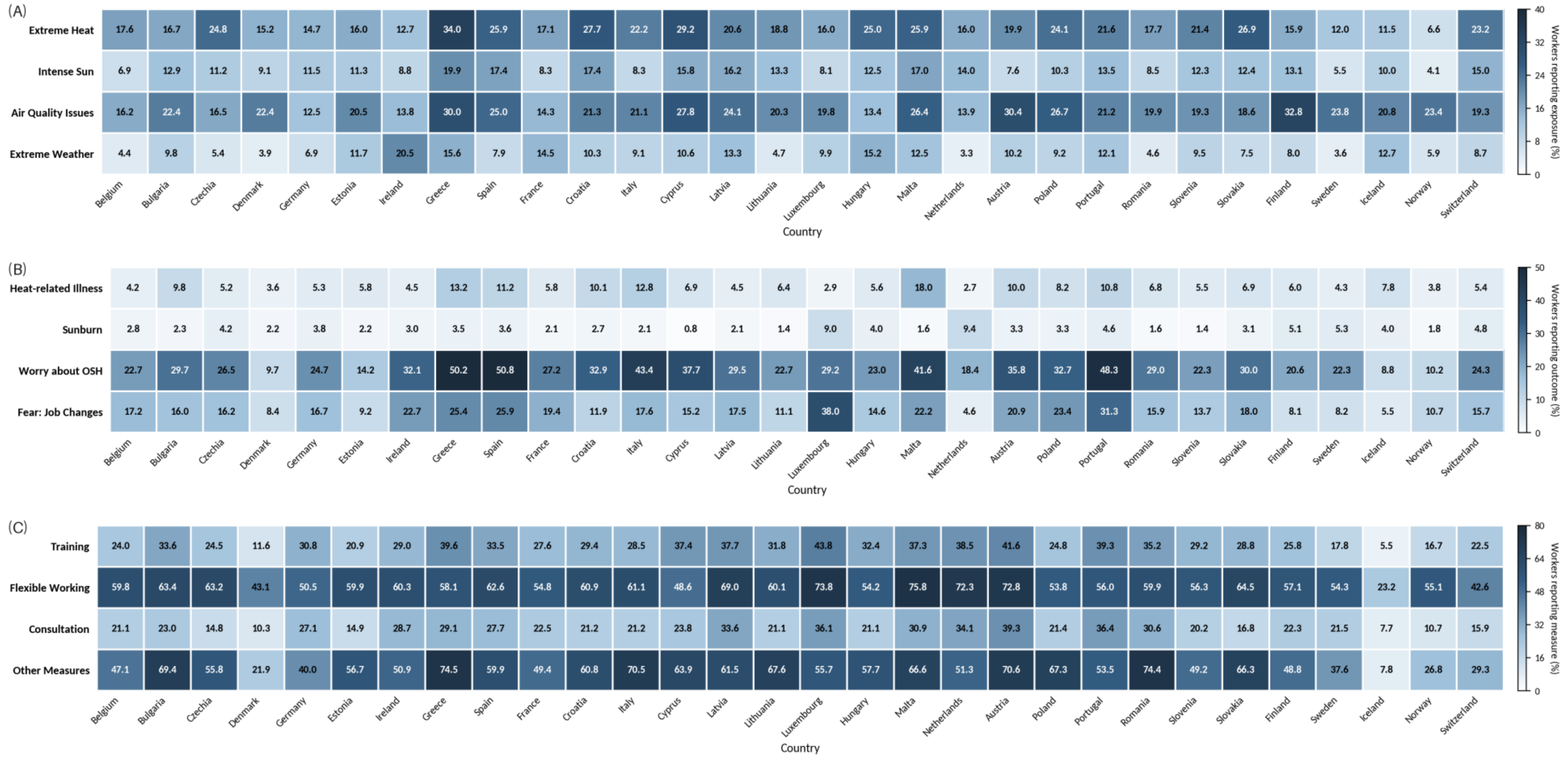
The most prevalent industry sectors were ICT/finance/professional/scientific services (16.2 %), commerce/transport/accommodation/food (16.1 %), and administration/public administration (14.5 %), with variation across countries. Occupational distribution showed professional and technical workers as the largest group (29.9 %), followed by clerical workers (16.0 %) and service workers (13.7 %), with cross-national differences observed. Most workers were employed on a permanent contract (71.9 %), 16.2 % were self-employed, and 11.9 % were employed on a temporary contract.

Climate-change related occupational exposures varied substantially across Europe (Figure 1A), with extreme heat affecting 19.6 % of workers (ranging from 6.6 % in Norway to 34.0 % in Greece). Intense sun exposure was reported by 11.1 % (ranging from 4.1 % in Norway to 19.9 % in Greece), air quality issues were experienced by 19.1 % (ranging from 12.5 % in Germany to 32.8 % in Finland), and extreme weather events impacted 9.0 % (ranging from 3.3 % in the Netherlands to 20.5 % in Ireland). All exposures showed cross-national variation.

Health outcomes demonstrated similarly marked geographic disparities (Figure 1B): heat-related illness was reported by 7.5 % of workers (ranging from 2.7 % in the Netherlands to 18.0 % in Malta), sunburn by 3.4 % (ranging from 0.8 % in Cyprus to 9.4 % in the Netherlands), worries about OSH by 31.6 % (ranging from 8.8 % in Iceland to 50.8 % in Spain), and fears about climate-change related job changes by 18.2 % (ranging from 4.6 % in the Netherlands to 38.0 % in Luxembourg). All outcomes differed by country.

Workplace preventive measures showed variable implementation or awareness (Figure 1C): 29.7 % of workers reported they had received climate-change related training (ranging from 5.5 % in Iceland to 43.8 % in Luxembourg), 57.3 % had access to flexible working arrangements (ranging from 23.2 % in Iceland to 75.8 % in Malta), 24.6 % reported consultation on climate adaptation (ranging from 7.7 % in Iceland to 39.3 % in Austria), and 54.6 % benefited from other protective measures (ranging from 7.8 % in Iceland to 74.5 % in Greece). All measures exhibited cross-national differences.

Figure 1: Heatmaps for the percentage of workers (N=23,330) A) Exposed to climate-change related risks in the workplace; B) Reporting climate-change related physical or mental health issues in the workplace; C) Reporting availability of preventive measures in the workplace to address climate-change related risks



5 Results

5.1 Exposure to climate-change related hazards in the workplace by social and occupational groups (RQ1)

Occupational characteristics were the strongest and most consistent predictors of climate-change related workplace exposures across all four examined exposures (extreme heat, intense sun, poor air quality and extreme weather). Box 4 summarises the results for these exposures and additional summary charts for all outcomes can be found in the appendix.

Among occupation types, farm workers had the highest predicted probability of exposure to heat (59.5 % unadjusted, 52.7 % adjusted), sun (46.6 % unadjusted, 30.6 % adjusted), poor air quality (62.0 % unadjusted, 63.2 % adjusted) and extreme weather (29.4 % unadjusted, 21.0 % adjusted).

Semi-skilled and unskilled workers also showed markedly elevated probabilities for heat and air quality exposure, with adjusted predicted probabilities ranging from 54.4 % to 62.2 %, compared to 7.6 %-11.9 % among professional, clerical and administrative occupations.

By industry sector, workers in agriculture, forestry and fishing had the highest unadjusted predicted probabilities for heat (35.2 %), sun (27.7 %), air quality (32.9 %) and extreme weather (15.9 %) exposure; however, adjustment for covariates attenuated these sector-level differences, particularly for sun and air quality exposure.

Outdoor workers consistently showed higher predicted probabilities than indoor workers across all four exposures, with the adjusted gap most pronounced for heat (24.3 % v 19.3 %) and sun (20.1 % v 10.5 %).

The attenuation of differences following adjustment was most marked for education level, where a clear unadjusted gradient – with workers with lower levels of education showing higher exposure probabilities than workers with higher levels of education for heat (26.7 % v 17.7 %), sun (13.5 % v 9.8 %), and air quality (26.9 % v 19.2 %) – largely converged after adjustment.

Differences by gender, migrant status and age group were modest across all four exposure outcomes, with male and migrant workers generally displaying higher exposure, and younger age groups displaying lower exposure.

There were modest differences across exposures for employment contract type. Self-employed workers had slightly higher adjusted predicted probabilities than those on permanent or temporary contracts for heat (21.2 % v 19.4 % and 18.5 %), sun (13.7 % v 10.7 % and 10.5 %), and extreme weather (10.2 % v 8.6 % and 8.6 %), with little variation in poor air quality exposure (21.3 % v 20.6 % and 20.5 %).

Box 4: Predicted probabilities for each climate-change related exposure (unadjusted/adjusted)

	Heat	Sun	Poor air quality	Extreme weather
Industry sector — Admin & Support	0.23 / 0.19	0.12 / 0.09	0.24 / 0.20	0.09 / 0.08
Industry sector — Agriculture/Forestry	0.23 / 0.35	0.16 / 0.28	0.20 / 0.33	0.10 / 0.16
Industry sector — Energy/Extraction	0.21 / 0.25	0.13 / 0.16	0.16 / 0.19	0.08 / 0.08
Industry sector — Manufacturing/Eng.	0.16 / 0.19	0.08 / 0.09	0.19 / 0.21	0.08 / 0.08
Industry sector — Construction	0.21 / 0.27	0.14 / 0.20	0.22 / 0.28	0.09 / 0.11
Industry sector — Commerce/Transport/Food	0.18 / 0.19	0.10 / 0.10	0.18 / 0.19	0.10 / 0.10
Industry sector — ICT/Finance/Sci.	0.19 / 0.16	0.12 / 0.10	0.21 / 0.18	0.07 / 0.07
Industry sector — Education	0.22 / 0.19	0.12 / 0.10	0.26 / 0.23	0.10 / 0.09
Industry sector — Health/Social Care	0.19 / 0.18	0.11 / 0.10	0.22 / 0.21	0.09 / 0.09
Industry sector — Social/Culture/Other	0.19 / 0.20	0.10 / 0.11	0.17 / 0.18	0.09 / 0.09
Occupation type — Professional/Technical	0.11 / 0.11	0.06 / 0.06	0.12 / 0.12	0.09 / 0.09
Occupation type — Higher Admin	0.08 / 0.08	0.04 / 0.04	0.08 / 0.08	0.08 / 0.07
Occupation type — Clerical	0.08 / 0.08	0.04 / 0.04	0.09 / 0.09	0.07 / 0.07
Occupation type — Sales	0.09 / 0.09	0.03 / 0.03	0.09 / 0.09	0.07 / 0.07
Occupation type — Service	0.16 / 0.15	0.09 / 0.09	0.16 / 0.16	0.10 / 0.10
Occupation type — Skilled	0.56 / 0.55	0.32 / 0.33	0.59 / 0.58	0.10 / 0.11
Occupation type — Semi-skilled	0.59 / 0.58	0.36 / 0.37	0.62 / 0.60	0.09 / 0.10
Occupation type — Unskilled	0.57 / 0.56	0.33 / 0.34	0.54 / 0.53	0.08 / 0.09
Occupation type — Farm worker	0.53 / 0.59	0.31 / 0.47	0.63 / 0.62	0.21 / 0.29
Employment contract — Self-employed	0.21 / 0.23	0.14 / 0.16	0.21 / 0.22	0.10 / 0.11
Employment contract — Permanent contract	0.19 / 0.19	0.11 / 0.11	0.21 / 0.21	0.09 / 0.09
Employment contract — Temporary contract	0.19 / 0.20	0.11 / 0.11	0.20 / 0.22	0.09 / 0.09
Outdoor work — No	0.19 / 0.19	0.10 / 0.10	0.21 / 0.20	0.08 / 0.08
Outdoor work — Yes	0.24 / 0.34	0.20 / 0.30	0.23 / 0.31	0.18 / 0.21
Migrant — No	0.20 / 0.20	0.11 / 0.11	0.21 / 0.21	0.09 / 0.09
Migrant — Yes	0.20 / 0.21	0.12 / 0.13	0.20 / 0.21	0.08 / 0.08
Age group — 16 - 24 years	0.16 / 0.17	0.08 / 0.09	0.21 / 0.21	0.07 / 0.08
Age group — 25 - 39 years	0.20 / 0.20	0.11 / 0.11	0.22 / 0.21	0.09 / 0.10
Age group — 40 - 54 years	0.21 / 0.21	0.12 / 0.12	0.21 / 0.22	0.09 / 0.10
Age group — 55 years and older	0.19 / 0.20	0.11 / 0.12	0.19 / 0.19	0.08 / 0.08
Gender — Male	0.20 / 0.22	0.12 / 0.14	0.20 / 0.22	0.10 / 0.11
Gender — Female	0.19 / 0.18	0.10 / 0.09	0.21 / 0.20	0.07 / 0.07
Education level — Low	0.21 / 0.27	0.10 / 0.13	0.22 / 0.27	0.09 / 0.10
Education level — Medium	0.19 / 0.24	0.12 / 0.16	0.19 / 0.25	0.10 / 0.11
Education level — High	0.20 / 0.18	0.11 / 0.10	0.21 / 0.19	0.08 / 0.08

5.2 Climate-related physical and mental health outcomes by social and occupational groups (RQ2)

Occupational patterning was similarly evident for climate-change related physical and mental health outcomes, though the magnitude and direction of associations differed across these outcomes. Box 5 summarises the results for these outcomes.

For heat-related illness and sunburn, which were the two physical health outcomes examined, predicted probabilities were relatively low overall, but farm workers showed substantially elevated risks relative to other groups: adjusted predicted probabilities for heat-related illness were 12.8 % among farm workers, compared to 4.5 %-9.1 % among other occupation types. For sunburn, the risk was 4.7 %, compared to 1.4 %-4.2 %.

Outdoor workers had adjusted predicted probabilities of 8.5 % for heat-related illness and 7.0 % for sunburn, compared to 6.8 % and 3.0 % respectively for indoor workers. For sunburn in particular, the unadjusted estimate for farm workers (11.2 %) more than halved after adjustment (4.7 %). Among demographic predictors, migrant workers had higher adjusted predicted probabilities for both heat-related illness (9.1 % v 6.7 %) and sunburn (4.8 % v 3.1 %) than non-migrant workers.

Concerns about OSH were the highest of any outcome examined, with most groups showing adjusted predicted probabilities in the range of 24 %-34 %.

Farm workers again showed the highest levels of concern about OSH (41.3 % adjusted) and about job changes due to climate-change related preventive measures (27.5 % adjusted), though the spread across occupation types was narrower for these outcomes than for physical exposures.

Outdoor workers had adjusted predicted probabilities of 34.6 % for OSH worries, and 20.7 % for worries about climate-change related preventive measures, compared to 28.1 % and 16.1 % respectively for indoor workers.

Migrant workers reported higher adjusted probabilities for both worry outcomes – 30.7 % v 28.2 % for OSH, and 19.3 % v 16.0 % for climate-change related preventive measures – while differences by education level were small and remained largely stable across unadjusted and adjusted models.

Males were generally more concerned than females about both climate-change related OSH and about job changes due to climate-change related preventive measures.

Employment contract type showed limited patterning for health outcomes. Temporary contract workers had modestly higher adjusted worries about OSH (30.9 %) compared to those on a permanent contract (28.1 %) and self-employed workers (28.1 %). Differences in worries about climate-change related preventive measures were similarly modest, with temporary contract workers showing 18.9 %, compared to 16.0 % for permanent contract workers. Differences in physical health outcomes (heat-related illness and sunburn) were small across employment contract types.

Box 5: Predicted probabilities for each climate-change related health outcome (unadjusted/adjusted)

	Worry: prevention	Worry: OSH	Health: heat	Health: sunburn
Industry sector — Admin & Support	0.14 / 0.14	0.29 / 0.29	0.07 / 0.07	0.03 / 0.02
Industry sector — Agriculture/Forestry	0.22 / 0.27	0.30 / 0.34	0.07 / 0.09	0.06 / 0.08
Industry sector — Energy/Extraction	0.17 / 0.17	0.24 / 0.25	0.06 / 0.06	0.04 / 0.05
Industry sector — Manufacturing/Eng.	0.20 / 0.20	0.29 / 0.29	0.08 / 0.08	0.03 / 0.03
Industry sector — Construction	0.19 / 0.20	0.30 / 0.31	0.06 / 0.07	0.04 / 0.06
Industry sector — Commerce/Transport/Food	0.18 / 0.18	0.29 / 0.28	0.08 / 0.08	0.03 / 0.03
Industry sector — ICT/Finance/Sci.	0.15 / 0.15	0.28 / 0.28	0.05 / 0.05	0.03 / 0.03
Industry sector — Education	0.13 / 0.13	0.29 / 0.29	0.07 / 0.07	0.04 / 0.03
Industry sector — Health/Social Care	0.12 / 0.11	0.27 / 0.27	0.07 / 0.07	0.02 / 0.02
Industry sector — Social/Culture/Other	0.19 / 0.19	0.29 / 0.29	0.08 / 0.08	0.04 / 0.04
Occupation type — Professional/Technical	0.15 / 0.16	0.28 / 0.29	0.07 / 0.07	0.03 / 0.03
Occupation type — Higher Admin	0.14 / 0.14	0.29 / 0.29	0.06 / 0.06	0.01 / 0.01
Occupation type — Clerical	0.15 / 0.14	0.26 / 0.26	0.05 / 0.05	0.03 / 0.02
Occupation type — Sales	0.17 / 0.18	0.25 / 0.26	0.05 / 0.05	0.03 / 0.03
Occupation type — Service	0.17 / 0.16	0.31 / 0.31	0.08 / 0.08	0.04 / 0.04
Occupation type — Skilled	0.19 / 0.20	0.30 / 0.30	0.09 / 0.09	0.04 / 0.05
Occupation type — Semi-skilled	0.16 / 0.17	0.27 / 0.27	0.08 / 0.08	0.04 / 0.05
Occupation type — Unskilled	0.23 / 0.25	0.28 / 0.28	0.08 / 0.09	0.03 / 0.04
Occupation type — Farm worker	0.28 / 0.36	0.41 / 0.44	0.13 / 0.14	0.05 / 0.11
Employment contract — Self-employed	0.16 / 0.18	0.28 / 0.29	0.07 / 0.07	0.04 / 0.05
Employment contract — Permanent contract	0.16 / 0.16	0.28 / 0.28	0.07 / 0.07	0.03 / 0.03
Employment contract — Temporary contract	0.19 / 0.19	0.31 / 0.31	0.07 / 0.08	0.03 / 0.04
Outdoor work — No	0.16 / 0.16	0.28 / 0.28	0.07 / 0.07	0.03 / 0.03
Outdoor work — Yes	0.21 / 0.24	0.35 / 0.36	0.09 / 0.09	0.07 / 0.10
Migrant — No	0.16 / 0.16	0.28 / 0.28	0.07 / 0.07	0.03 / 0.03
Migrant — Yes	0.19 / 0.20	0.31 / 0.31	0.09 / 0.09	0.05 / 0.05
Age group — 16 - 24 years	0.17 / 0.18	0.30 / 0.30	0.07 / 0.08	0.04 / 0.05
Age group — 25 - 39 years	0.17 / 0.17	0.27 / 0.27	0.07 / 0.07	0.03 / 0.03
Age group — 40 - 54 years	0.17 / 0.17	0.28 / 0.28	0.07 / 0.07	0.04 / 0.04
Age group — 55 years and older	0.16 / 0.16	0.30 / 0.30	0.06 / 0.06	0.02 / 0.02
Gender — Male	0.18 / 0.19	0.29 / 0.30	0.07 / 0.07	0.04 / 0.04
Gender — Female	0.15 / 0.14	0.27 / 0.27	0.07 / 0.07	0.02 / 0.02
Education level — Low	0.19 / 0.20	0.26 / 0.27	0.09 / 0.10	0.03 / 0.04
Education level — Medium	0.15 / 0.17	0.27 / 0.28	0.08 / 0.09	0.04 / 0.05
Education level — High	0.17 / 0.16	0.29 / 0.29	0.06 / 0.06	0.03 / 0.03

5.3 Availability of preventive measures for climate-change related risks by social and occupational groups (RQ3)

The availability of workplace preventive measures was relatively high across all groups and showed less variation by occupational or demographic characteristics than the exposure and health outcomes. Box 6 summarises the results for these variables.

Flexible working arrangements had the highest predicted probabilities of any outcome examined, with adjusted estimates ranging from 48.7 % (education sector) to 67.7 % (agriculture/forestry/fishing) by sector, and from 52.9 % (farm workers) to 62.3 % (semi-skilled workers) by occupation type. Differences between unadjusted and adjusted estimates were negligible for flexible working across all predictors, indicating that uptake was not substantially influenced by the demographic and occupational factors included in the model.

Other prevention measures showed a similarly flat profile, with adjusted predicted probabilities between 45.4 % and 58.9 % across sectors and 50.0 %-57.0 % across occupation types.

Training and consultation showed somewhat more variation: farm workers had the highest adjusted probabilities for both training (35.6 %) and consultation (32.7 %).

Outdoor workers had slightly higher probabilities than indoor workers for training and consultation. Demographic differences were small throughout: migrant workers had lower training probabilities than non-migrant workers (26.6 % v 29.7 %), and male workers had marginally higher training probabilities than female workers (30.9 % v 27.5 %), but differences by education level and age group were minimal and adjustment had little effect on any of these estimates.

Employment contract type showed little variation in access to preventive measures. Training probabilities were slightly higher among temporary (30.5 %) and permanent contract workers (29.8 %) than among the self-employed (26.2 %). Flexible working, consultation and other preventive measures showed minimal differences across employment contract types (flexible working: 57.7 %-59.3 %; consultation: 22.3 %-24.0 %; other measures: 53.6 %-54.4 %).

Box 6: Predicted probabilities for each climate-change related preventive measure variable (unadjusted/adjusted)

	Training	Flexible working	Consultation	Other measures
Industry sector — Admin & Support	0.33 / 0.33	0.60 / 0.60	0.25 / 0.24	0.55 / 0.55
Industry sector — Agriculture/Forestry	0.35 / 0.36	0.68 / 0.67	0.34 / 0.35	0.56 / 0.56
Industry sector — Energy/Extraction	0.29 / 0.30	0.59 / 0.60	0.28 / 0.29	0.59 / 0.60
Industry sector — Manufacturing/Eng.	0.30 / 0.30	0.63 / 0.63	0.24 / 0.24	0.57 / 0.58
Industry sector — Construction	0.31 / 0.32	0.61 / 0.61	0.26 / 0.27	0.56 / 0.57
Industry sector — Commerce/Transport/Food	0.29 / 0.29	0.57 / 0.58	0.22 / 0.22	0.54 / 0.54
Industry sector — ICT/Finance/Sci.	0.29 / 0.29	0.60 / 0.60	0.24 / 0.24	0.55 / 0.55
Industry sector — Education	0.25 / 0.24	0.49 / 0.48	0.23 / 0.22	0.45 / 0.45
Industry sector — Health/Social Care	0.26 / 0.26	0.54 / 0.53	0.19 / 0.18	0.51 / 0.50
Industry sector — Social/Culture/Other	0.28 / 0.28	0.59 / 0.58	0.23 / 0.23	0.53 / 0.53
Occupation type — Professional/Technical	0.28 / 0.27	0.57 / 0.57	0.23 / 0.23	0.54 / 0.54
Occupation type — Higher Admin	0.30 / 0.30	0.62 / 0.62	0.24 / 0.24	0.54 / 0.54
Occupation type — Clerical	0.27 / 0.27	0.59 / 0.59	0.22 / 0.22	0.54 / 0.54
Occupation type — Sales	0.28 / 0.28	0.60 / 0.61	0.23 / 0.23	0.56 / 0.57
Occupation type — Service	0.32 / 0.31	0.55 / 0.54	0.24 / 0.23	0.50 / 0.49
Occupation type — Skilled	0.33 / 0.34	0.59 / 0.60	0.26 / 0.27	0.55 / 0.56
Occupation type — Semi-skilled	0.31 / 0.32	0.62 / 0.63	0.24 / 0.25	0.57 / 0.58
Occupation type — Unskilled	0.29 / 0.29	0.58 / 0.58	0.26 / 0.26	0.51 / 0.51
Occupation type — Farm worker	0.30 / 0.36	0.53 / 0.61	0.24 / 0.33	0.53 / 0.55
Employment contract — Self-employed	0.26 / 0.27	0.59 / 0.59	0.22 / 0.23	0.54 / 0.55
Employment contract — Permanent contract	0.30 / 0.30	0.58 / 0.58	0.24 / 0.24	0.54 / 0.54
Employment contract — Temporary contract	0.30 / 0.30	0.58 / 0.57	0.22 / 0.22	0.54 / 0.53
Outdoor work — No	0.29 / 0.29	0.58 / 0.58	0.23 / 0.23	0.54 / 0.54
Outdoor work — Yes	0.35 / 0.36	0.60 / 0.62	0.26 / 0.29	0.53 / 0.54
Migrant — No	0.30 / 0.30	0.58 / 0.58	0.24 / 0.24	0.54 / 0.54
Migrant — Yes	0.27 / 0.27	0.58 / 0.58	0.22 / 0.22	0.52 / 0.53
Age group — 16 - 24 years	0.29 / 0.30	0.60 / 0.60	0.27 / 0.27	0.53 / 0.53
Age group — 25 - 39 years	0.31 / 0.30	0.60 / 0.60	0.23 / 0.23	0.53 / 0.53
Age group — 40 - 54 years	0.29 / 0.29	0.58 / 0.58	0.23 / 0.23	0.54 / 0.54
Age group — 55 years and older	0.28 / 0.28	0.57 / 0.57	0.23 / 0.24	0.54 / 0.54
Gender — Male	0.31 / 0.31	0.59 / 0.59	0.25 / 0.25	0.55 / 0.55
Gender — Female	0.28 / 0.27	0.58 / 0.57	0.22 / 0.22	0.52 / 0.52
Education level — Low	0.26 / 0.26	0.58 / 0.58	0.24 / 0.24	0.55 / 0.56
Education level — Medium	0.30 / 0.31	0.59 / 0.59	0.24 / 0.25	0.54 / 0.54
Education level — High	0.29 / 0.29	0.58 / 0.58	0.23 / 0.23	0.54 / 0.53

5.4 Intersectional analysis (RQ4)

Cross-classifying occupational group, education, migration status and gender produced 32 possible intersectional profiles, all of which were observed in the analytic sample of 23,330 workers. Across the 30 countries, these formed 862 country-specific strata, 90 % of the 960 possible country-by-profile combinations, with a median strata size of 11 workers (mean 27, range 1-315). There were fewer than 10 respondents in 402 strata (47 %), including 81 with a single respondent; together these sparse strata comprised 1,601 workers (6.9 % of the sample). They were retained in all models with precision-weighted estimates, and sensitivity analyses excluding them are reported below.

The three outcomes showed different patterns of variation (Table 1). Exposure to extreme heat was heavily concentrated in particular intersectional groups: in the null model, 42.5 % of its total variation lay between country-specific strata, compared to only 3.8 % between countries. Heat-related illness showed a more diffuse pattern, with strata and countries accounting for similar, modest shares of variation (5.0 % and 5.2 %). In the case of concerns about OSH, only 2.0 % of its variation lay between intersectional groups compared to 8.6 % between countries. In short, **social and occupational position seems to determine which workers are exposed to workplace heat**, while **national context is what shapes which workers are worried about climate-change related OSH risk**, more than a worker's own circumstances.

Table 1: Key results from the intersectional (MAIHDA) analysis for the three outcomes

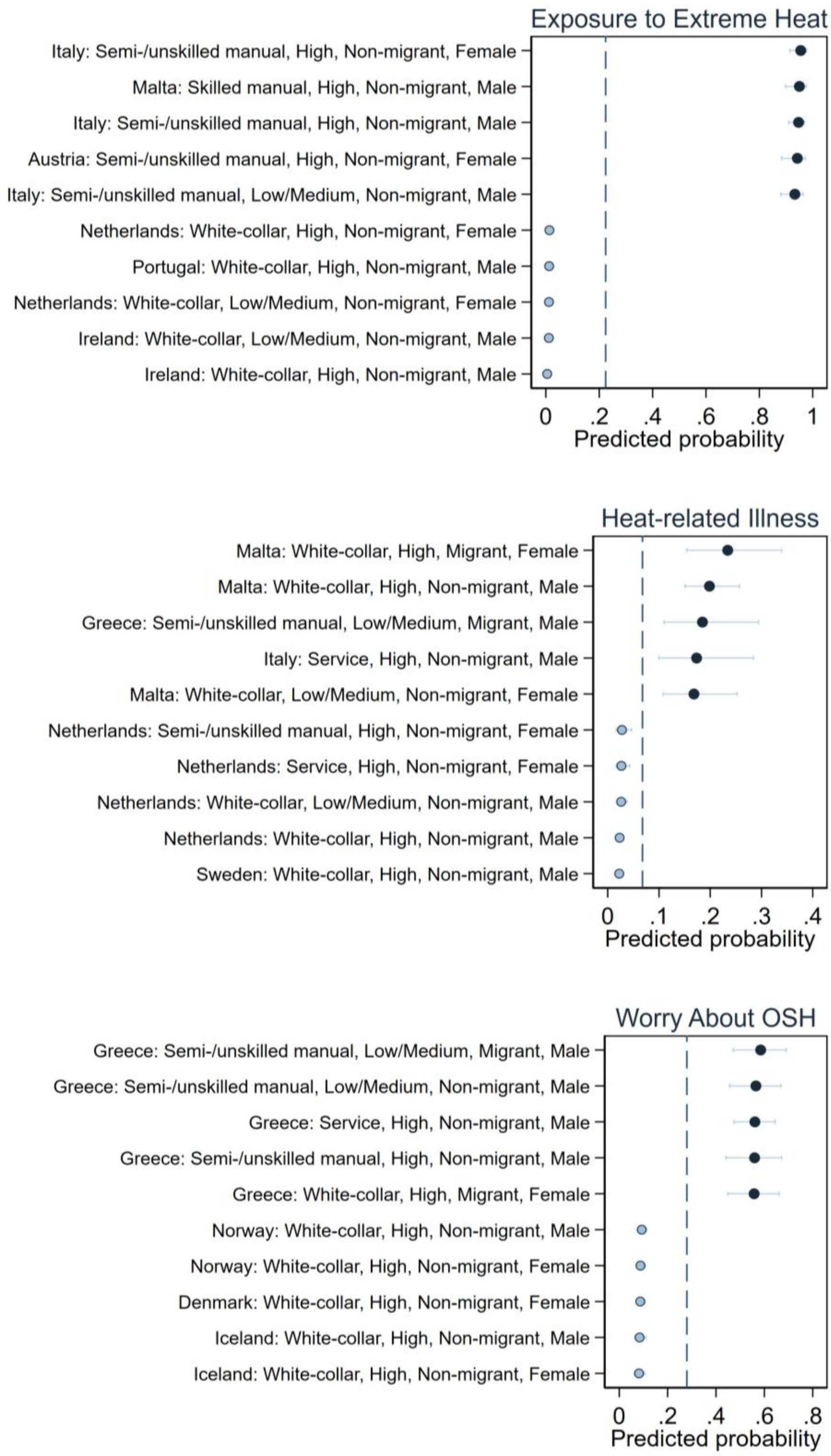
	Exposure to extreme heat	Heat-related illness	Worries about OSH
Null model (Model A)			
VPC, intersectional strata	0.425	0.050	0.020
VPC, countries	0.038	0.052	0.086
Additive model (Model B)			
VPC, intersectional strata (residual)	0.227	0.015	0.011
PCV, %	60.1	70.2	48.2
Sensitivity analysis: strata with n ≥ 10 (n = 21,729)			
VPC, intersectional strata (null model)	0.455	0.047	0.015
VPC, countries (null model)	0.006	0.049	0.092

Notes: Intersectional strata are country-specific groups defined by occupation group (4 categories) × education (2) × migration status (2) × gender (2); 32 profiles, 862 observed country strata across 30 countries. VPC = variance partition coefficient (share of total outcome variation attributable to each level). PCV = proportional change in stratum-level variance from the null to the additive model, which adds the main effects of the stratum-defining characteristics plus age group. The residual stratum VPC reflects between-strata differences remaining after these additive effects. The sensitivity analysis excludes strata with fewer than 10 respondents.

The main effects of the four stratum-defining characteristics (occupation, education, migration status and gender) plus age group explained around half to two thirds of the between-strata variation in each outcome: 60.1 % for heat exposure, 70.2 % for heat-related illness and 48.2 % for worries. After adjustment, a substantial share of between-strata variation in heat exposure persisted (residual stratum VPC: 22.7 %), indicating that particular combinations of characteristics carry risk beyond the sum of their parts. Under the country-specific stratification used here, this residual captures both intersectional interaction effects and cross-national differences in which groups are most exposed. For heat-related illness and worries, residual stratum variance was small (VPCs of 1.5 % and 1.1 %), suggesting that these outcomes are adequately described by the independent contributions of each characteristic. Country-level variance was essentially unchanged between the null and adjusted models for all three, indicating that between-country differences are contextual rather than compositional. In other words, countries do not differ in these outcomes because their workforces differ in social and occupational make-up.

Across Europe and within individual countries, the strata with the highest predicted probabilities of heat exposure were overwhelmingly manual (Figure 2). Of the 150 strata occupying countries' five highest-risk positions, 123 were skilled or semi-/unskilled manual workers, while lower/medium education levels featured in 78. The lowest-risk positions were dominated by white-collar workers (80 of 150 strata) and were typically highly educated. The equivalent rankings for heat-related illness and worries about OSH showed a similar pattern, with manual workers and groups with lower levels of education again over-represented among the highest-risk positions, although the differences were less pronounced. This is consistent with the weaker intersectional patterning of these outcomes. The appendix also contains figures by country.

Figure 2: Highest- and lowest-risk intersectional strata across all countries for all three outcomes



Dark markers = 5 highest-risk strata; light markers = 5 lowest-risk;
dashed line = median stratum in a typical country.
Ranking restricted to strata with at least 10 respondents;
all strata were included in model estimation.

5.4.1 Sensitivity analysis

When all models were re-estimated with sparse strata excluded (1,601 workers; n = 21,729), the substantive conclusions were unchanged. The stratum-level VPC for heat exposure was slightly larger than in the main analysis (0.455 v 0.425), indicating that the intersectional patterning of this outcome is not attributable to small strata. VPCs for heat-related illness (0.047 v 0.050) and worries about OSH (0.015 v 0.020) were similar, as were the PCVs for all three outcomes (63.9 %, 70.0 % and 45.7 %, compared to 60.1 %, 70.2 % and 48.2 %). The exception was the country-level VPC for heat exposure, which fell from 0.038 to 0.006 when sparse strata were excluded. This suggests that much of the between-country variation in heat exposure derives from small, country-specific strata, and country-level estimates for this outcome should be interpreted with caution.

In the strata rankings with sparse strata excluded, 119 of the 150 highest risk positions for heat exposure remained manual, and roughly two thirds of individual strata were common to both versions. The main exception concerned migrant strata, which fell from 48 to 13 of the top positions for heat exposure when sparse strata were excluded. This reflects that migrants form a small group (11 % of the sample) whose intersectional strata are rarely large. Excluding sparse strata disproportionately removes those combinations of greatest substantive interest, supporting the approach of retaining them with shrunken estimates, rather than excluding them.

All in all, the findings reveal considerable disparities in exposure to climate hazards, health consequences, and availability of climate-change related preventive measures across European workplaces. The intersectional analysis further quantified how these risks concentrate within combinations of occupational and social characteristics. These patterns carry significant implications for OSH policy, practice and research in the context of accelerating climate change that will be analysed more in detail in the next section.

6 Implications for OSH

As discussed in the previous section, the data analysis shows considerable disparities in a number of dimension including exposure to climate hazards, health consequences, and availability of climate change-related preventive measures across European workplaces. The analysis quantified how these risks concentrate within combinations of occupational and social characteristics. In this section it will be displayed how these findings carry significant implications for OSH policy, practice and research.

6.1 Concentration of climate change-related occupational risks in vulnerable sectors and job categories

The findings demonstrate that climate-change related occupational hazards are not distributed uniformly across the European workforce but are concentrated among workers in specific sectors and job categories characterised by outdoor work, manual labour, and limited workplace control.

Workers in agriculture, forestry and fishing consistently exhibited the highest risk of exposure to heat, sun, poor air quality, and adverse weather conditions, alongside elevated risk of heat-related health outcomes and sunburn. These sectoral patterns align with prior European job exposure assessments indicating that agriculture and other manual, high metabolic rate occupations carry the highest annual heat stress hours and exposure burden, with countries in southern Europe and jobs involving local heat sources the most affected (de Crom, et al., 2026).

Job category analyses revealed pronounced disparities, with farm workers exhibiting markedly elevated risk across multiple exposure outcomes: heat, sun, air quality, adverse weather and sunburn.

Skilled, semi-skilled and unskilled workers similarly demonstrated substantially elevated risk of environmental exposures compared to higher-level administrative and clerical workers. These findings underscore that climate-change related occupational risks are strongly stratified by occupational class and skill level, with manual and outdoor workers bearing disproportionate burdens.

The intersectional analysis reinforces this conclusion. Exposure to extreme heat was strongly concentrated among manual workers with lower or medium levels of education, who occupied most of the highest-risk positions in every country. Occupation explained much of this pattern, but some combinations of characteristics carried more risk than their individual parts would suggest, so prevention aimed at single characteristics would miss part of the burden. Risk of heat-related illness was spread more evenly across the workforce, meaning protection for the most exposed groups is necessary but not sufficient.

Given that heat exposure reduces labour capacity and increases the risk of heat-related illness and injury, with projected labour productivity losses and region-specific vulnerability highlighted in pan-European analyses (Casanueva, et al., 2020) (Pogačar, et al., 2018) (Szewczyk, Mongelli, & Ciscar, 2021), these disparities represent a significant and growing challenge for OSH equity and possible linked social protection in Europe.

6.2 Preventive measures and training for high-risk workers

Despite the concentration of climate-change related exposures and health outcomes among outdoor and manual workers, the findings reveal gaps in preventive measures and training for these high-risk groups. While farm workers and skilled workers demonstrated one of the highest probabilities of receiving heat or climate change-related training, migrant workers who exhibited an elevated risk of adverse heat-related and sun-related health outcomes showed a reduced probability of receiving training.

Consultation about climate and heat risks, was elevated among agriculture, forestry and fishing workers and energy and extraction workers, and was lower among health and social care workers.

Flexible working arrangements, as a preventive measure, demonstrated limited sectoral variation and no significant associations with outdoor work, educational attainment or migrant status. These findings indicate that current preventive approaches may not adequately reach the workers most exposed to climate change-related occupational hazards, highlighting the need for more targeted OSH interventions.

Limited availability of preventive measures among high-risk groups is particularly concerning, given the evidence that effective workplace adaptation requires a combination of environmental monitoring, organisational controls, engineering solutions and worker training (Morabito, et al., 2019) (de Crom, et al., 2026) (Marinaccio, et al., 2025). Policies should focus on practical, evidence-based workplace measures including occupational heat-health warning systems, the rescheduling of heavy tasks to cooler periods of the working day, the provision of shaded rest areas and hydration, and comprehensive training on heat risks and acclimatisation procedures (Morabito, et al., 2019) (Morris, et al., 2021) (de Crom, et al., 2026) (Marinaccio, et al., 2025). The current findings suggest that such measures may not be systematically implemented for the workers who need them most.

6.3 Elevated risks among migrant workers and implications for health equity

The finding that migrant workers exhibited a significantly elevated risk of heat-related health outcomes and sunburn, despite showing no dramatically different levels of exposure to adverse heat, sun, air quality or weather conditions, is particularly noteworthy and raises important questions about vulnerability, adaptation and health equity. This pattern suggests that migrant workers may experience greater health consequences from equivalent levels of exposure, potentially reflecting differences in acclimatisation, access to protective resources, work intensity, ability to take breaks, or underlying health status. The concurrent finding that migrant workers demonstrated a reduced likelihood of receiving heat or climate change-related training further compounds this vulnerability. The intersectional analysis substantiates this interpretation. Within comparable occupational, educational and gender groups, migrant workers were no more likely than non-migrants to report exposure to extreme heat, yet were significantly more likely to experience heat-related illness, a pattern consistent with heightened vulnerability at equivalent levels of exposure rather than with differential exposure itself.

These disparities align with broader concerns about occupational health inequalities among migrant workers in Europe and underscore the need for OSH policies that explicitly address the heightened vulnerability of this population. Given that climate change-driven increases in ambient and workplace heat will increase health risks, reduce labour productivity and increase heat-related injuries for physically demanding outdoor jobs, concentrating burdens in southern regions and among unacclimatised workers (Casanueva, et al., 2020) (Pogačar, et al., 2018) (de Crom, et al., 2026) (Marinaccio, et al., 2025) (Szewczyk, Mongelli, & Ciscar, 2021), targeted interventions for migrant workers are essential. Such interventions should include culturally and linguistically appropriate training, enhanced surveillance of heat-related health outcomes in migrant worker populations, and the enforcement of labour standards that ensure adequate rest, hydration and protective measures, regardless of employment status or migration background.

6.4 The role of collective bargaining in OSH adaptation

The observed disparities in exposure, health outcomes and preventive measures across occupational groups highlight the importance of social dialogue and collective bargaining in translating OSH evidence into enforceable workplace protections. Collective bargaining and trade unions can play a vital role in ensuring that climate adaptation measures are implemented in practice and that workers have meaningful inputs into risk assessment and prevention strategies. However, collective bargaining currently pays limited attention to heat in many countries, suggesting that this mechanism is underutilised in the context of climate-change related occupational risks (Riesco-Sanz, 2026).

The findings indicate that workers in sectors with elevated exposure, such as agriculture and construction, would benefit substantially from sector-specific collective agreements that mandate heat exposure monitoring, work-rest schedules, cooling and hydration provision, and training requirements. Moreover, the elevated concerns about job changes as a result of climate-change related adaptation measures among workers in agriculture, manufacturing, construction and other sectors, alongside elevated worries about OSH among farm workers and outdoor workers, suggest that workers themselves recognise these risks and may be receptive to collective action to address them. However, worries about the OSH impacts of climate change varied more between countries (8.6 % of total variation) than between intersectional groups (2.0 %), which is the reverse of the pattern for heat exposure. Although workers in higher-risk occupational groups reported greater worries, this gradient was modest relative to the gradient in exposure itself, suggesting that perceived risk does not closely track actual exposure. Social dialogue on climate adaptation cannot therefore assume that the most exposed workers are the most concerned, and national-level strategies for risk communication and worker engagement are likely to be at least as important as workplace-level ones. Strengthening the role of social dialogue in OSH adaptation is therefore both feasible and necessary to ensuring that climate-change related occupational risks are addressed equitably and effectively.

6.5 Strengths and limitations of the research

This analysis benefits from **several important methodological strengths** that enhance the validity and policy relevance of the findings.

First, the use of data from the OSH Pulse survey provides access to a large, multi-country sample of European workers, enabling the examination of climate-change related occupational exposures and outcomes across diverse national contexts, sectors and job categories. Europe-wide surveys such as this provide robust, policy-relevant information on working conditions, enabling identification of at-risk groups that inform OSH strategy.

Second, the broad content coverage of the OSH Pulse survey, which encompass employment status, physical and psychosocial risk factors, work organisation and health outcomes, supplies multi-dimensional evidence for policy-makers and researchers. This breadth enables the simultaneous examination of multiple climate-change related exposures, health outcomes, preventive measures and worker concerns within a single analytical framework, facilitating a comprehensive assessment of climate-change related occupational risks and responses.

The use of multilevel logistic regression models in this analysis appropriately accounts for the hierarchical structure of the data, with workers nested within countries, and enables the examination of individual-level factors, while accounting for country-level effects. This approach is well-suited to the analysis of cross-national survey data and provides a robust framework for identifying associations between occupational characteristics and climate-change related outcomes while accounting for between-country variation.

The intersectional analysis extended this framework to provide an explicitly intersectional assessment of differences and inequalities. Rather than estimating the average effect of each characteristic separately, this approach treated each combination of occupation, education, migration status and gender as a distinct social position. It quantified how well these positions discriminate between workers with and without each outcome, and determined the contribution of characteristics acting additively from that of specific combinations. In addition, precision-weighted (shrunken) estimation stabilised the estimates for small groups, allowing rare but substantively important combinations such as migrant manual workers to be retained in the analysis.

Despite these strengths, this analysis is subject to **several limitations** related to survey design and measurement that affect the interpretation and generalisability of the findings.

First, while valuable for general working condition surveillance, available European surveys have limitations when used to study heat-related occupational health specifically, requiring complementary data and methods (Marinaccio, et al., 2025) (Morabito, et al., 2019) (de Crom, et al., 2026). The absence of objective exposure data means that this analysis relies on workers' subjective reports of exposure to heat, sun, air quality and adverse weather, which may be subject to recall bias, social desirability bias, or differences in perception and interpretation across individuals and cultural contexts. While self-reported exposure measures are widely used in occupational health research and can provide valuable information about workers' experiences, they do not capture the intensity, duration or timing of exposures with the precision required for detailed exposure-response modelling or for setting occupational exposure limits.

Second, periodic surveys are not designed to capture short-term heatwave timing, intensity or intra-day exposure fluctuations (Marinaccio, et al., 2025) (Morabito, et al., 2019). The OSH Pulse survey, like other cross-sectional surveys, provides a snapshot of working conditions at a single point in time and cannot capture the dynamic and episodic nature of heat exposure, which varies substantially across days, seasons and years in response to weather patterns and climate variability. This limitation is important for understanding acute heat-related health outcomes which may occur during brief but intense heat episodes that are not well-represented. Occupational heat surveillance and forecasting systems are needed in addition to survey data to capture these temporal dynamics (Marinaccio, et al., 2025) (Morabito, et al., 2019).

Third, cross-country cultural and structural differences affect how respondents interpret questions, complicating cross-national comparisons and construct validity without careful harmonisation. While the OSH Pulse survey employs standardised questionnaires and translation procedures to enhance comparability, differences in occupational structures, labour market institutions, OSH regulations and cultural norms regarding work and health may influence how workers in different countries perceive and report exposures and health outcomes. These differences may introduce measurement non-equivalence that is difficult to fully address through statistical adjustment.

Fourth, long questionnaires and survey design choices may limit the depth of sector- or task-level exposure information collected. The need to balance comprehensive coverage of working conditions with respondent burden means that climate-change related exposures and outcomes may be assessed with questions that are relatively brief or general and do not capture the full complexity of occupational heat stress or the specific tasks and conditions that contribute to exposure. This limitation constrains the ability to identify specific workplace interventions, or to tailor recommendations to particular job tasks or work environments.

Several limitations apply specifically to the intersectional analysis. First, strata were modelled as country-specific, so the residual between-group variation combines intersectional interaction effects with cross-national differences which cannot be separated in this design. Second, despite deliberately economical groupings of occupation (four categories) and education (two), nearly half of the country-specific groups contained fewer than 10 respondents (together comprising only 6.9% of workers). Sensitivity analyses excluding these sparse groups left the substantive conclusions unchanged, but the between-country share of variation in heat exposure proved sensitive to their exclusion and should be interpreted cautiously. In addition, rankings of individual groups within countries are indicative rather than definitive.

The cross-sectional design of the OSH Pulse survey and the observational nature of the data impose important limitations on causal inference. The observed associations between occupational characteristics and climate-change related outcomes do not necessarily reflect causal relationships, as they may be confounded by unmeasured variables or may reflect reverse causation. Longitudinal data that follow workers over time and capture changes in exposure, health status and employment would be required to establish temporal precedence and to rule out reverse causation.

Furthermore, the generalisability of the findings to specific national contexts, sectors or time periods may be limited by the heterogeneity of working conditions, climate exposures and OSH regulations across Europe. While the multilevel modelling approach accounts for between-country variation, the analysis does not examine country-specific associations or test for cross-national differences in the determinants of climate-change related occupational risks. The intersectional analysis partially addresses this by allowing every combination of characteristics to carry a country-specific effect, and its within-country rankings consistently identified manual, lower-educated groups as highest-risk across nearly all 30 countries. The findings should therefore be interpreted as representing average associations across the European sample, with the recognition that the magnitude and direction of associations may vary across countries and contexts.

Finally, the analysis focuses on a specific set of climate-change related exposures and outcomes measured in the OSH Pulse survey and does not capture the full range of climate-change related occupational risks, including extreme weather events, vector-borne diseases, or the indirect effects of climate change on employment and working conditions. The findings should therefore be interpreted as providing a partial picture of climate-change related occupational health in Europe, with the recognition that additional data sources and methods are needed to fully characterise the occupational health implications of climate change.

6.6 Implications for future research

The strengths and limitations of the analysis point to several priorities for future research on climate-change related occupational health in Europe.

First, there is a need for the development and validation of objective exposure measures that can be linked to survey data, such as job exposure matrices that combine occupational information with meteorological data and task-based exposure models (de Crom, et al., 2026). Such measures would enable more precise exposure-response modelling and would support the development of evidence-based occupational exposure limits.

Second, longitudinal studies that follow workers over time to capture changes in climate exposures, as well as changes in protective measures, health outcomes and employment are needed to establish causal relationships and to identify vulnerable subgroups and critical exposure windows. Such studies would also enable the effectiveness of workplace interventions and policy changes in reducing climate-change related occupational health risks to be evaluated.

Third, there is a need for more detailed, sector-specific and task-specific research that examines the mechanisms through which climate exposures affect worker health and productivity and that identifies effective intervention strategies tailored to particular work environments. This research should include both quantitative studies that examine exposure-response relationships and qualitative studies that explore workers' experiences, perceptions and adaptation strategies.

Fourth, the intersectional findings point to two further priorities. The observation that between-country differences in these outcomes were essentially unchanged after adjusting for workforce composition indicates that they are likely contextual rather than compositional. Therefore, identifying which national characteristics – for example, climate, OSH regimes, labour market institutions or risk communication – drive them requires models that incorporate country-level explanatory variables.

Finally, future research should examine the role of social dialogue, collective bargaining and OSH governance structures in shaping the distribution of climate-change related occupational risks and the implementation of preventive measures. Understanding how institutional and organisational factors influence OSH outcomes is essential for designing policies that promote equity and effectiveness in climate adaptation.

6.7 Policy pointers for climate-adaptive OSH in Europe

The findings from this analysis, considered alongside the broader literature on occupational heat and climate change in Europe, point to several urgent policy priorities.

First, **OSH policy must move from reactive heatwave responses to integrated, preventive frameworks that address exposure, work organisation and social protections**. This transition requires the adoption of occupationally specific heat standards, mandatory risk assessments, surveillance and early-warning systems, and linkage of OSH rules with labour standards and collective bargaining to ensure enforceable protections (Marinaccio, et al., 2025) (Morabito, et al., 2019) (De Sario, et al., 2023) (de Crom, et al., 2026).

Second, given the concentration of risks among outdoor and manual workers, particularly in agriculture and construction, **sector-specific interventions are essential**. Large multi-partner studies estimate substantial job losses and high annual economic costs from occupational heat stress (Flouris, Ioannu, & Nybo, 2024), supporting the need for policy action at EU level that prioritises these high-risk sectors. Such interventions should include mandatory heat exposure monitoring, the provision of cooling and hydration infrastructure, training and acclimatisation programmes, and enforcement mechanisms that ensure compliance.

Third, the **elevated vulnerability of migrant workers and the gaps in training and preventive measures for this population require targeted policy attention**. OSH policies should explicitly address the needs of migrant workers through culturally appropriate training, enhanced surveillance, and the enforcement of labour protections that do not depend on employment status or migration background.

Finally, the limited uptake of flexible working arrangements and consultation about climate change-related risks among high-risk workers suggests that current OSH governance structures may not be effectively engaging workers in risk assessment and prevention. **Strengthening social dialogue and collective bargaining mechanisms, alongside mandatory consultation requirements, is essential to ensure that climate adaptation measures are informed by worker knowledge and experience and are implemented equitably across the workforce**.

7 Conclusions

This study examined climate-change related occupational exposures, health outcomes and prevention measure availability across a range of occupational and demographic characteristics. An intersectional analysis then assessed the extent to which these risks were concentrated within particular combinations of occupational and social characteristics.

The findings consistently identify occupation type and industry sector as key determinants of differential risk across outcome domains. Farm workers and workers in the agriculture, forestry and fishing sectors faced the highest likelihood of exposure to extreme heat, intense sun, poor air quality and extreme weather, as well as the greatest risk of heat-related illness and sunburn, and the highest levels of worry about OSH and climate-change related preventive measures.

Outdoor work was the single most consistent predictor of elevated risk across exposure and health outcomes, with outdoor workers showing substantially higher probabilities than their indoor counterparts across nearly all outcomes examined.

The intersectional analysis showed that these inequalities are not merely additive. The reporting of exposure to extreme heat was strongly socially patterned, with particular combinations of characteristics carrying risk beyond the sum of their parts, and manual, lower-educated groups occupying the highest-risk positions in nearly every country. Worry about the OSH impacts of climate change showed the reverse pattern, varying more across countries than across groups, demonstrating that reported concern about climate-change related occupational risk tended to be shaped more by national context than by a worker’s own risk profile.

Differences by gender, age group and migrant status were generally modest for exposures and health outcomes, though migrant workers showed consistently elevated probability of reporting heat-related illness, sunburn and for both outcomes related to worries for the impact of climate change, which were not fully explained by the occupational and demographic characteristics included in the models.

In contrast to the pronounced inequalities observed for exposures and health outcomes, the availability of workplace prevention measures was broadly similar across occupational and demographic groups, with flexible working arrangements showing the highest and most uniformly distributed pattern of any outcome and consultation showing greater differences across sectors. This suggests that while preventive measures are generally widely available, they are not reaching those at greatest risk with sufficient specificity, and that targeted occupational health interventions, particularly for farm workers, outdoor workers and migrant workers, are needed to address the occupational inequalities in climate-change related health risk identified in this study.

References

Alsaleh, M., Xia, T., & Abdul-Rahim, A. (2025). From Climate Change to Occupational Risks: The Vulnerability of the Fisheries Sector to Climatic Accidents. Israeli Journal of Aquaculture - Bamidgeh, 77(3), 267-285. https://doi.org/10.46989/001c.144566

Bernard, N., Sagawa, Y., Bier, N., Lihoreau, T., Pazart, L., & Tannou, T. (2025). Using artificial intelligence for systematic review: the example of elicit. BMC medical research methodology, 25(1), 75. https://doi.org/10.1186/s12874-025-02528-y

Brooks, S., & Greenberg, N. (2023). Climate change effects on mental health: are there workplace implications? Occupational medicine (Oxford, England), 73(3), 133-137. https://doi.org/10.1093/occmed/kqac100

Casanueva, A., Kotlarski, S., Fischer, A., Flouris, A., Kjellstrom, T., Lemke, B., . . . Liniger, M. (2020). Escalating environmental summer heat exposure—a future threat for the European workforce. Reg Environ Change, 20, 40. https://doi.org/10.1007/s10113-020-01625-6

de Crom, T., Scholten, B., Traini, E., van der Sanden, K., Kingma, B., Pekel, F., . . . Pronk, A. (2026). Exposure to heat at work: development of a quantitative European job exposure matrix (heat JEM). Scandinavian journal of work, environment & health, 52(1), 7-18. https://doi.org/10.5271/sjweh.4243

De Sario, M., de'Donato, F., Bonafede, M., Marinaccio, A., Levi, M., Ariani, F., . . . Michelozzi, P. (2023). Occupational heat stress, heat-related effects and the related social and economic loss: a scoping literature review. Frontiers in public health, 11, 1173553. https://doi.org/10.3389/fpubh.2023.1173553

Drescher, K., & Janzen, B. (2025). When weather wounds workers: The impact of temperature on workplace accidents. Journal of Public Economics. https://doi.org/10.1016/j.jpubeco.2024.105258

Errico, E., & Di Nunzio, D. (2026). Heatwaves and occupational health and safety in Italy: the role of trade unions and social dialogue. Industrial health, 64(1), 96-106. https://doi.org/10.2486/indhealth.2025-0107

EU-OSHA. (2025). OSH Pulse 2025: Occupational safety and health in the era of climate and digital change.

Evans, C., Leckie, G., Subramanian, S., Bell, A., & Merlo, J. (2024). A tutorial for conducting intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA). SSM - population health, 26, 101664. https://doi.org/10.1016/j.ssmph.2024.101664

Evans, C., Williams, D., Onnela, J., & Subramanian, S. (2018). A multilevel approach to modeling health inequalities at the intersection of multiple social identities. Social science & medicine (1982), 203, 64-73. https://doi.org/10.1016/j.socscimed.2017.11.011

Fatima, S., Rothmore, P., Giles, L., Varghese, B., & Bi, P. (2021). Extreme heat and occupational injuries in different climate zones: A systematic review and meta-analysis of epidemiological evidence. Environment International, 148, 106384. https://doi.org/10.1016/j.envint.2021.106384

Flouris, A., Ioannu, L., & Nybo, L. (2024). SS51-03 From research to public policy: how the Heat-Shield project has influenced policy in the European Union (EU). Occupational Medicine, 74. https://doi.org/10.1093/occmed/kqae023.0302

Hilkenmeier, F., Pelzer, M., Stierle, C., & Fink-Lamotte, J. (2025). Evaluating the AI Tool "Elicit" as a Semi-Automated Second Reviewer for Data Extraction in Systematic Reviews: A Proof-of-Concept. Social Science Computer Review, 0(0), 1-17. https://doi.org/10.1177/08944393251404052

Koch, S., Buekers, J., Espinosa, A., Gómez-Salgado, J., Pombo, G., Werkman, L., . . . O'Callaghan-Gordo, C. (2025). Association between objectively assessed physical activity and kidney function among female agricultural workers in hot environments in Spain. Environmental research, 276, 121420. https://doi.org/10.1016/j.envres.2025.121420

Lam, W., Demou, E., & Ho, F. (2026). Environmental hazards at work and mental health: a UK Biobank Retrospective Cohort Study. Journal of occupational and environmental medicine. https://doi.org/10.1097/JOM.0000000000003790

Lau, O., & Golder, S. (2025). Comparison of Elicit AI and Traditional Literature Searching in Evidence Syntheses Using Four Case Studies. Cochrane evidence synthesis and methods, 3(6), e70050. https://doi.org/10.1002/cesm.70050

Levi, M., Kjellstrom, T., & Baldasseroni, A. (2018). Impact of climate change on occupational health and productivity: a systematic literature review focusing on workplace heat. La Medicina del lavoro, 109(3), 163-179. https://doi.org/10.23749/mdl.v109i3.6851

Makembi Bunkete, A. (2026). Mesoamerican nephropathy as a potential contributor to chronic allograft dysfunction in tropical settings. Transplant international: official journal of the European Society for Organ Transplantation, 39, 16621. https://doi.org/10.3389/ti.2026.16621

Marinaccio, A., Gariazzo, C., Taiano, L., Bonafede, M., Martini, D., D'Amario,, S., . . . Worklimate working group. (2025). Climate change and occupational health and safety. Risk of injuries, productivity loss and the co-benefits perspective. Environmental research, 269, 120844. https://doi.org/10.1016/j.envres.2025.120844

Marinaccio, A., Scortichini, M., Gariazzo, C., Leva, A., Bonafede, M., De' Donato, F., . . . BEEP Collaborative Group. (2019). Nationwide epidemiological study for estimating the effect of extreme outdoor temperature on occupational injuries in Italy. Environment international, 133(Pt A), 105176.

Martínez-Solanas, È., López-Ruiz, M., Wellenius, G., Gasparrini, A., Sunyer, J., Benavides, F., & Basagaña, X. (2018). Evaluation of the Impact of Ambient Temperatures on Occupational Injuries in Spain. Environmental health perspectives, 126(6), 067002.

Mazzalai , E., De Sario, M., Turner, G., Natukunda, J., Nordeng, Z., Aunan, K., . . . de'Donato, F. (2023). Adaptation to heat and concomitant environmental risks in Europe: a GAP Analysis. European Journal of Public Health, 33. https://doi.org/10.1093/eurpub/ckad160.368

Messeri, A., Morabito, M., Bonafede, M., Bugani, M., Levi, M., Baldasseroni, A., . . . Marinaccio, A. (2019). Heat Stress Perception among Native and Migrant Workers in Italian Industries-Case Studies from the Construction and Agricultural Sectors. International journal of environmental research and public health, 16(7), 1090. https://doi.org/10.3390/ijerph16071090

Morabito, M., Messeri, A., Casanueva, A., Crisci, A., Kotlarski, S., Orlandini, S., . . . Nybo, L. (2019). An Occupational Heat-Health Warning System for Europe: The HEAT-SHIELD Platform. International journal of environmental research and public health, 16(16), 2890. https://doi.org/10.3390/ijerph16162890

Morris, N., Levi, M., Morabito, M., Messeri, A., Ioannou, L., Flouris, A., . . . Nybo, L. (2020). Health vs. wealth: Employer, employee and policy-maker perspectives on occupational heat stress across multiple European industries. Temperature (Austin, Tex.), 8(3), 284-301. https://doi.org/10.1080/23328940.2020.1852049

Morris, N., Piil, J., Morabito, M., Messeri, A., Levi, M., Ioannou, L., . . . Nybo, L. (2021). The HEAT-SHIELD project - Perspectives from an inter-sectoral approach to occupational heat stress. Journal of science and medicine in sport, 24(8), 747-755. https://doi.org/10.1016/j.jsams.2021.03.001

Niedzwiedz, C., Kankawale, S., & Katikireddi, S. (2025). A systematic review of social, political and geographic factors associated with eco-anxiety in children and young people. Nature Mental Health, 3, 1579-1615. https://doi.org/10.1038/s44220-025-00550-z

Niedzwiedz, C., Olsen, J., Rizeq, J., Afework, T., Hill-Harding, C., Shaw, R., . . . Papies, E. (2025). Coming to terms with climate change: a glossary for climate change impacts on mental health and well-being. Journal of epidemiology and community health, 79(4), 295-301. https://doi.org/10.1136/jech-2024-222716

Paterson, S., & Godsmark, C. (2020). Heat-health vulnerability in temperate climates: lessons and response options from Ireland. Globalization and health, 16(1), 29. https://doi.org/10.1186/s12992-020-00554-7

Pogačar, T., Casanueva, A., Kozjek, K., Ciuha, U., Mekjavić, I., Kajfež Bogataj, L., & Črepinšek1, Z. (2018). The effect of hot days on occupational heat stress in the manufacturing industry: implications for workers' well-being and productivity. International journal of biometeorology, 1251-1264. https://doi.org/10.1007/s00484-018-1530-6

Riesco-Sanz, A. (2026). Collective bargaining and social dialogue as instruments to protect workers from heatwaves and climate change in the European Union. Industrial health, 64(1), 45-60. https://doi.org/10.2486/indhealth.2025-0112

Salas-Nicás, S., & Laabbas-El-Guennouni, M. (2026). Heat stress and social dialogue in Spain. Industrial health, 64(1), 84-95. https://doi.org/10.2486/indhealth.2025-0105

Sanchez Polo, V., Garcia-Trabanino, R., Rodriguez, G., & Madero, M. (2020). Mesoamerican Nephropathy (MeN): What We Know so Far. International journal of nephrology and renovascular disease, 13, 261-272. https://doi.org/10.2147/IJNRD.S270709

Szewczyk, W., Mongelli, I., & Ciscar, J. (2021). Heat stress, labour productivity and adaptation in Europe—a regional and occupational analysis. Environmental Research Letters, 16, 105002. https://doi.org/10.1088/1748-9326/ac24cf

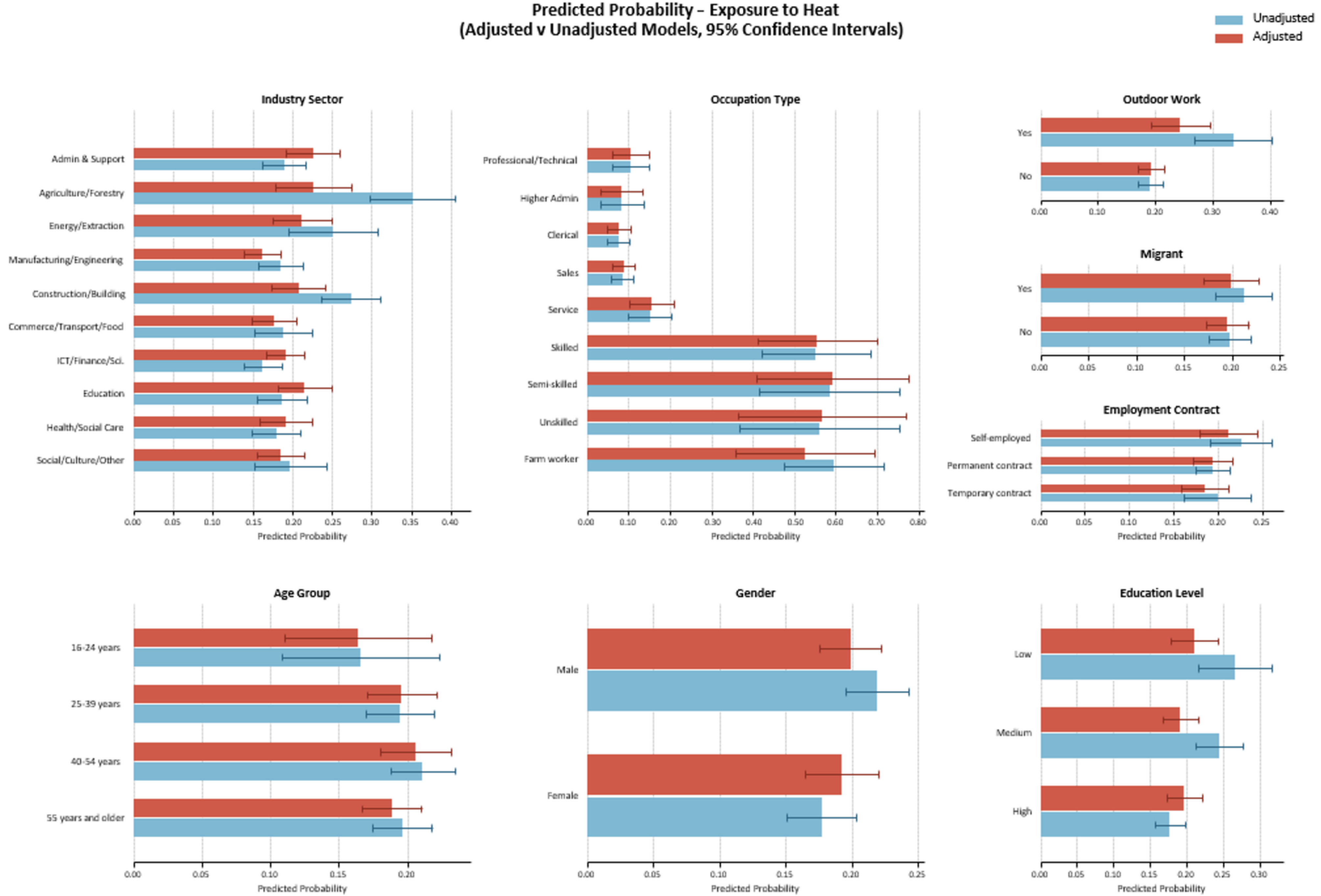
Tóth, K. (2026). ADAPTHEAT heatwaves and occupational health and safety in Hungary: the role of social dialogue. Industrial health, 64(1), 76-83. https://doi.org/10.2486/indhealth.2025-0085

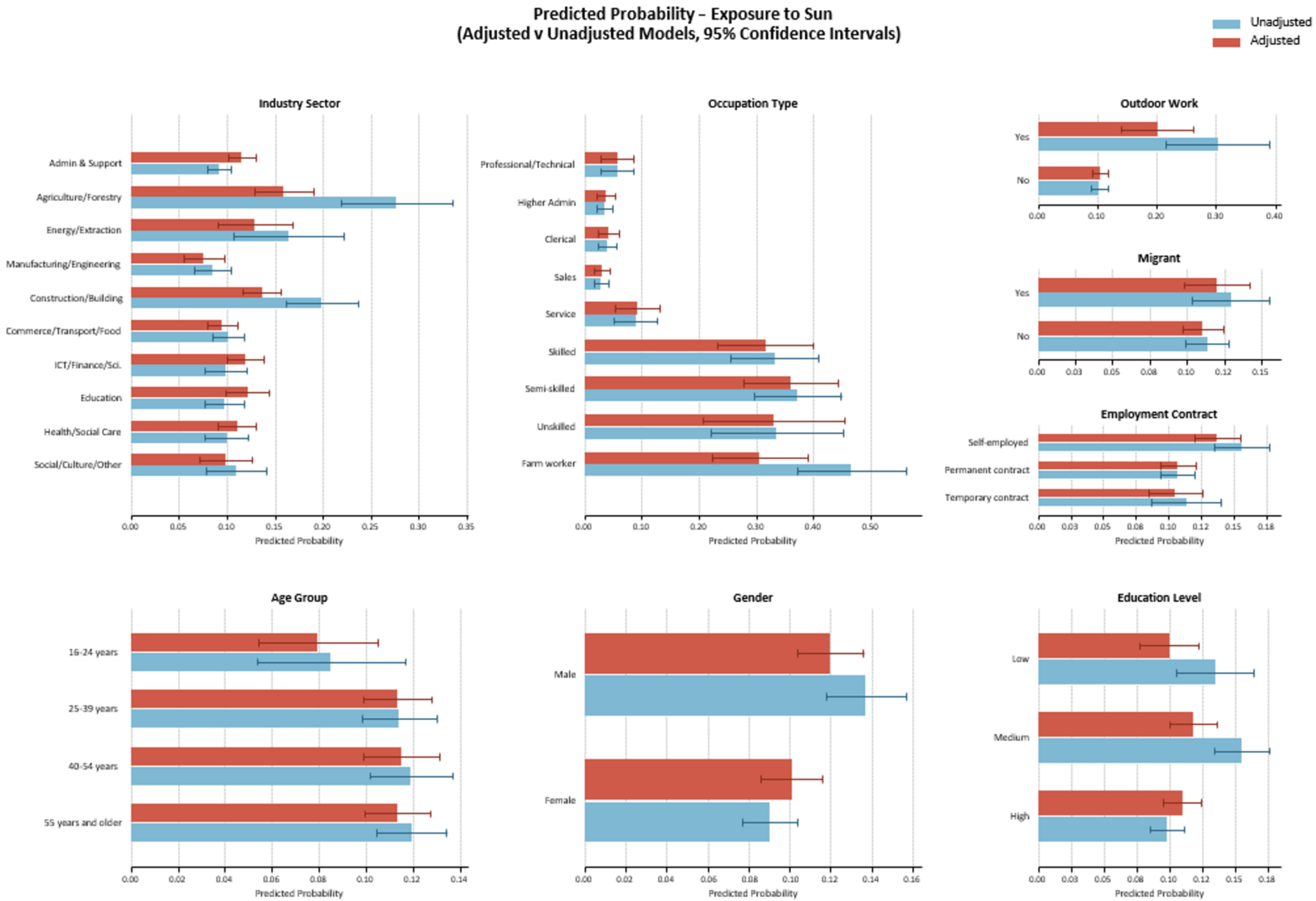
Turner, M., Basagaña, X., Albin, M., Broberg, K., Burdorf, A., van Daalen, K., . . . Straif, K. (2025). Occupational health in the era of climate change and the green transition: a call for research. The Lancet Regional Health, 54, 101353. https://doi.org/10.1016/j.lanepe.2025.101353

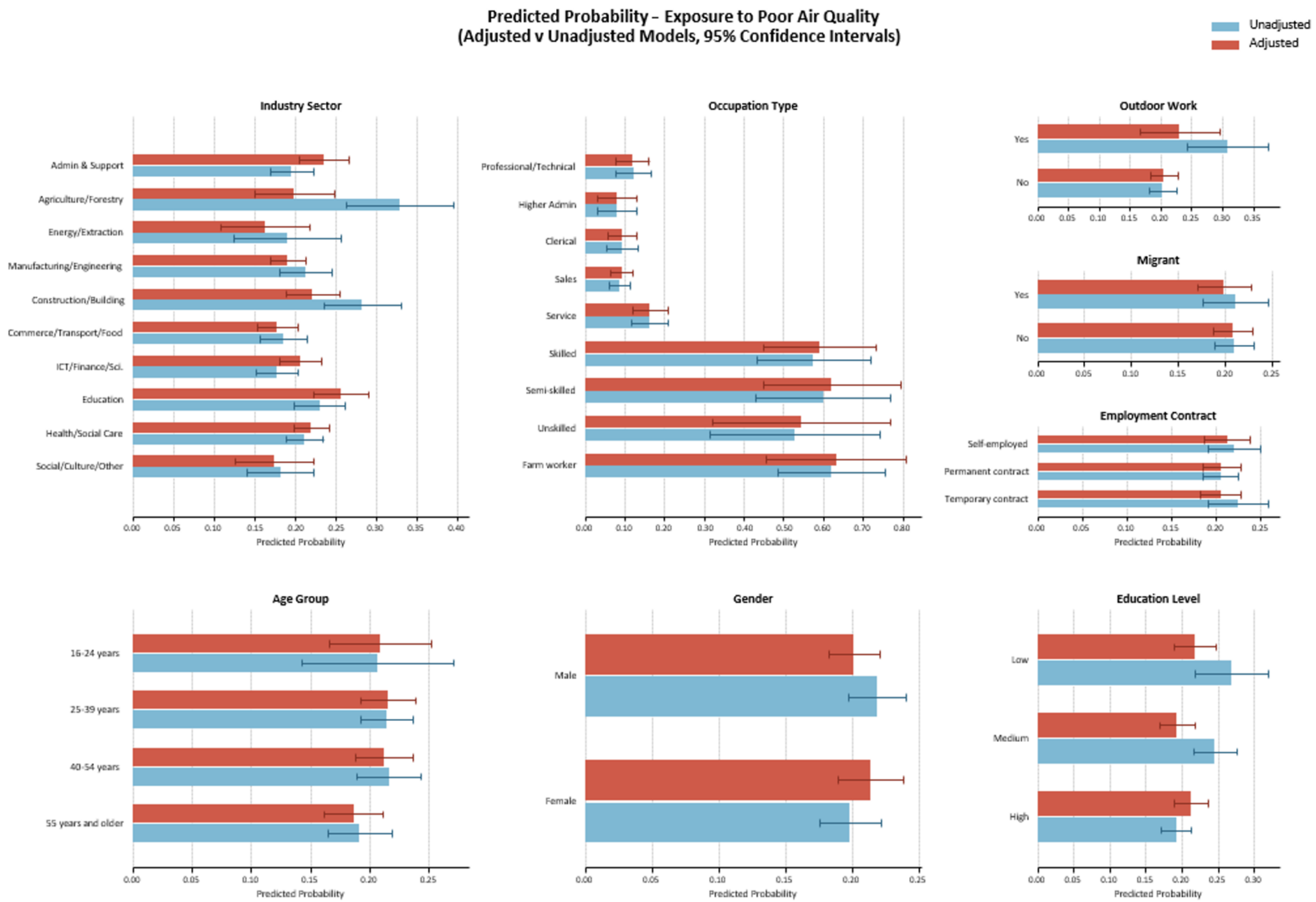
Whitfield, S., & Hofmann, M. (2023). Elicit: AI literature review research assistant. Public Services Quarterly, 19, 201-207. https://doi.org/10.1080/15228959.2023.2224125

Appendix

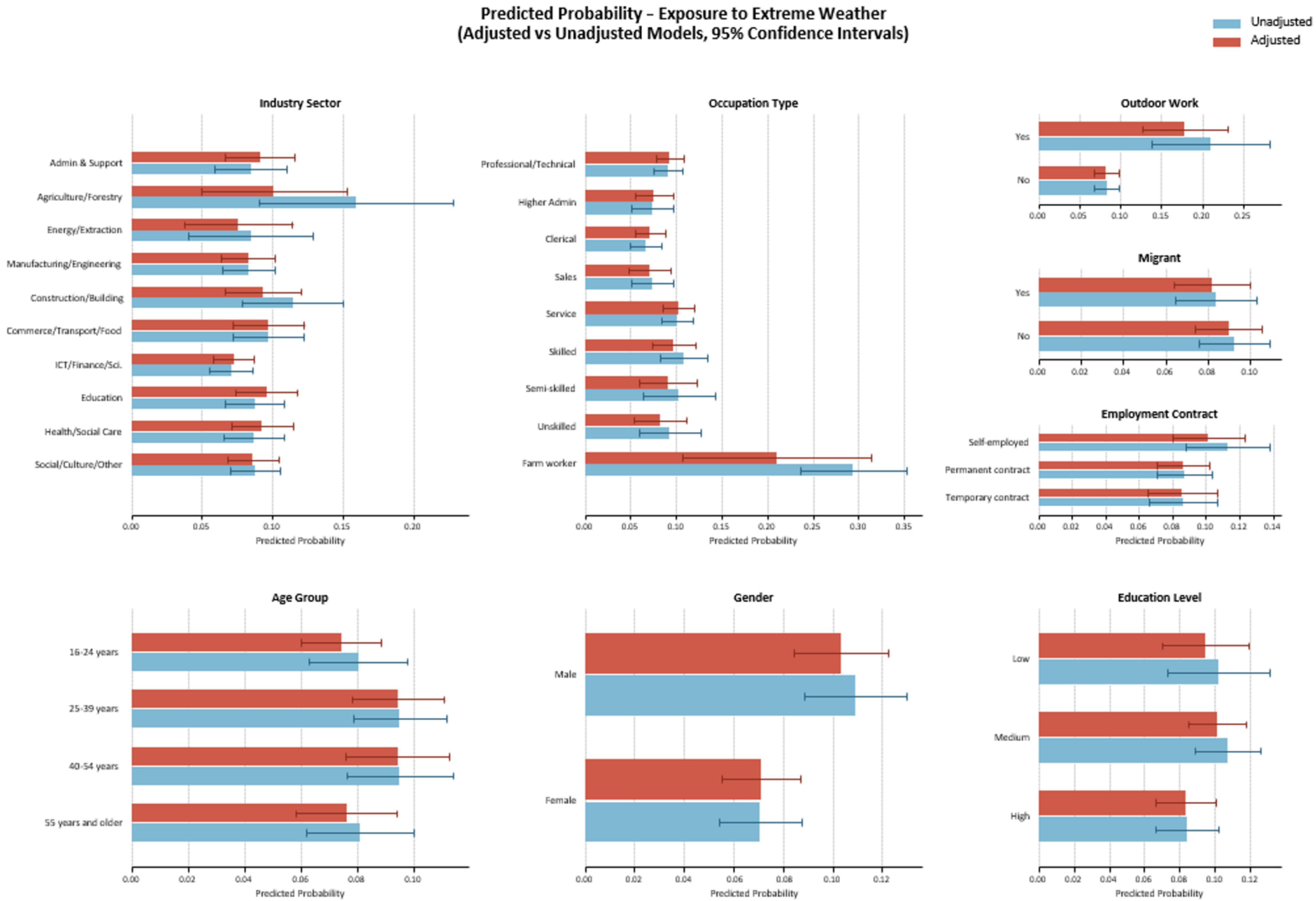
Predicted Probability – Exposure to Heat
(Adjusted v Unadjusted Models, 95% Confidence Intervals)



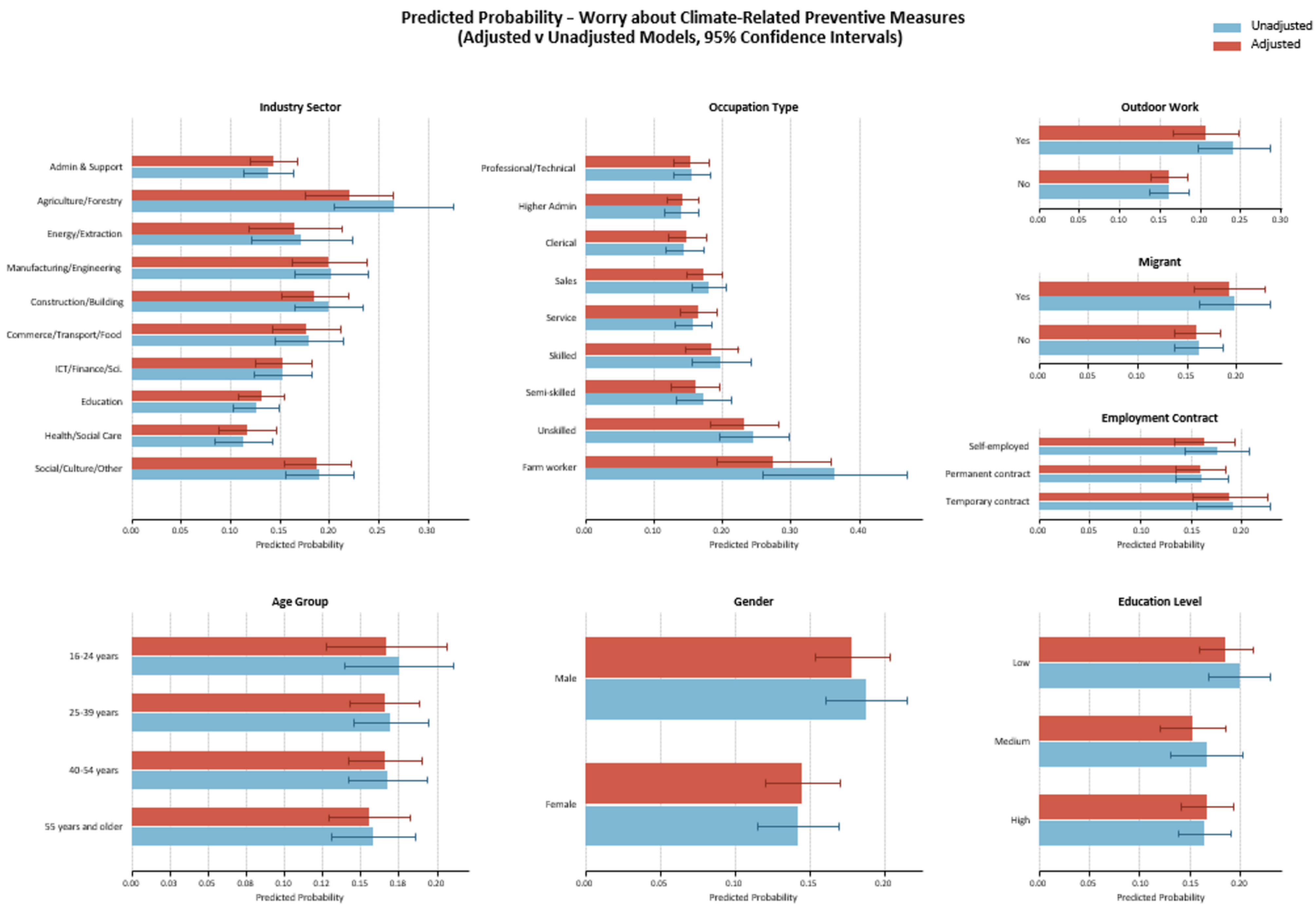

Predicted Probability – Exposure to Sun
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
Predicted Probability
Outdoor Work
Yes
No
Migrant
Yes
No
Employment Contract
Self-employed
Permanent contract
Temporary contract
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
Predicted Probability
Gender
Male
Female
Predicted Probability
Education Level
Low
Medium
High
Predicted Probability

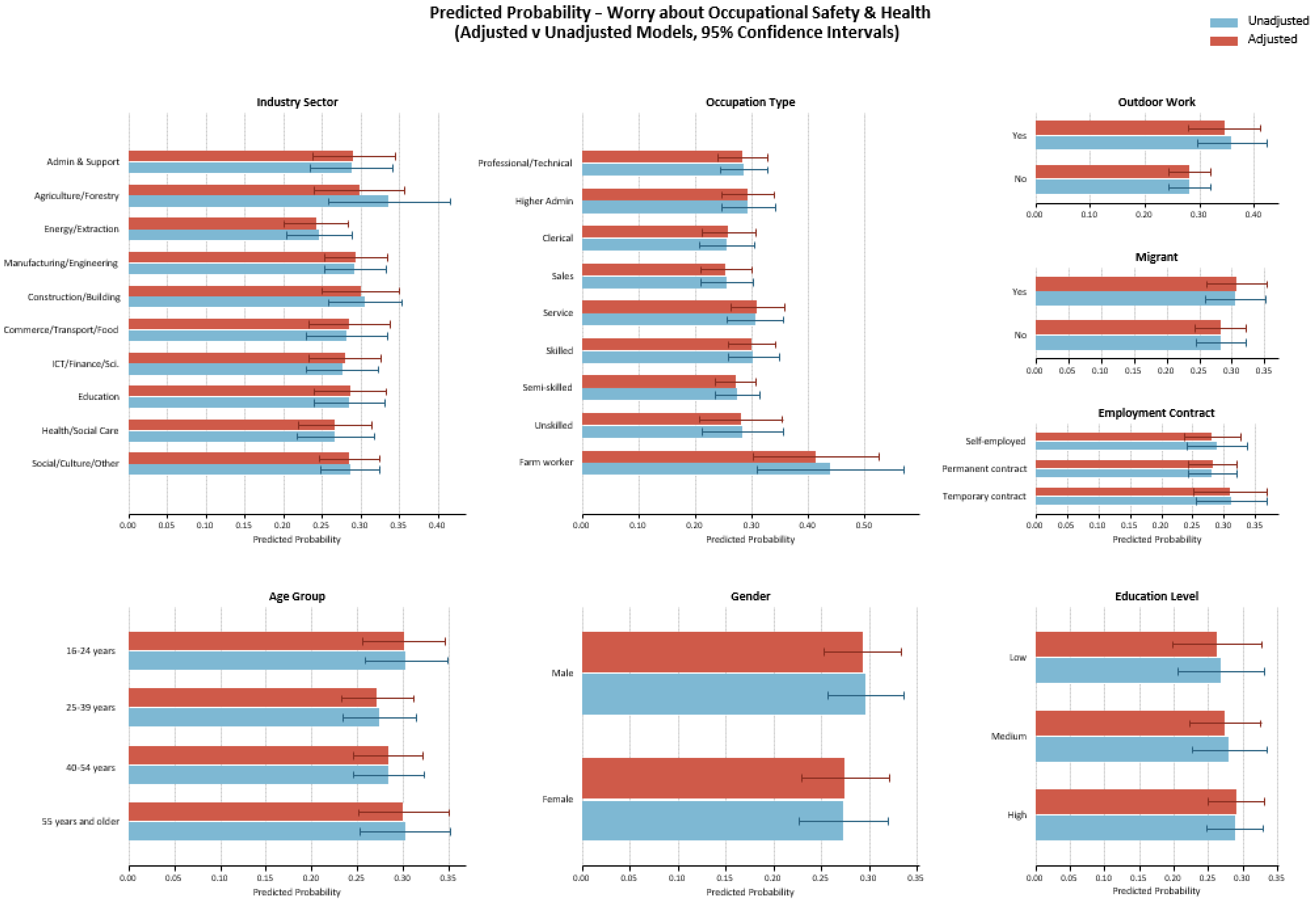


Predicted Probability – Exposure to Poor Air Quality
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80
Predicted Probability
Outdoor Work
Yes
No
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35
Migrant
Yes
No
0.00 0.05 0.10 0.15 0.20 0.25
Employment Contract
Self-employed
Permanent contract
Temporary contract
0.00 0.05 0.10 0.15 0.20 0.25
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
0.00 0.05 0.10 0.15 0.20 0.25
Predicted Probability
Gender
Male
Female
0.00 0.05 0.10 0.15 0.20 0.25
Predicted Probability
Education Level
Low
Medium
High
0.00 0.05 0.10 0.15 0.20 0.25 0.30
Predicted Probability

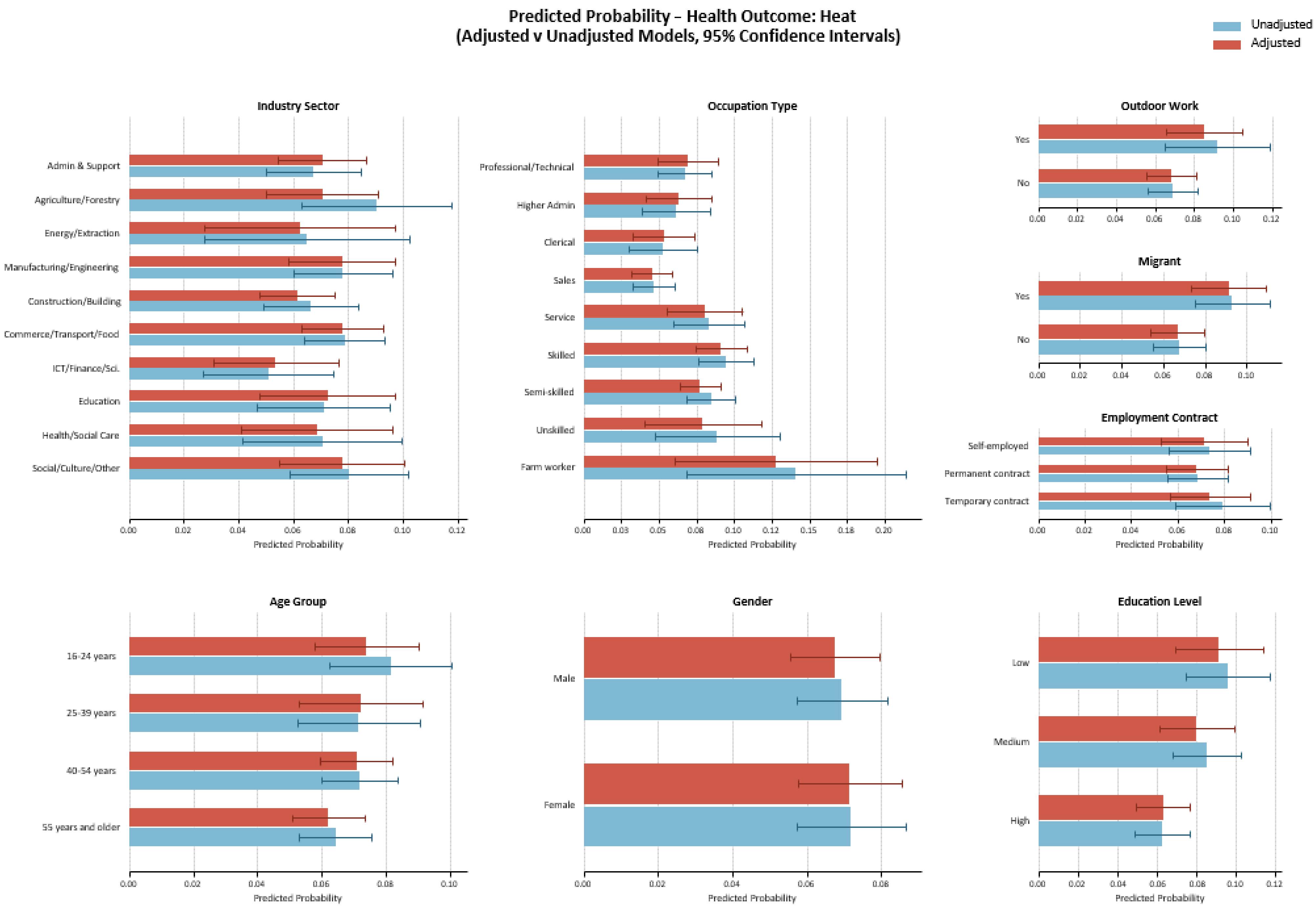


Predicted Probability – Exposure to Extreme Weather
(Adjusted vs Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
0.00 0.05 0.10 0.15 0.20
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35
Predicted Probability
Outdoor Work
Yes
No
0.00 0.05 0.10 0.15 0.20 0.25
Migrant
Yes
No
0.00 0.02 0.04 0.06 0.08 0.10
Employment Contract
Self-employed
Permanent contract
Temporary contract
0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
0.00 0.02 0.04 0.06 0.08 0.10
Predicted Probability
Gender
Male
Female
0.00 0.02 0.04 0.06 0.08 0.10 0.12
Predicted Probability
Education Level
Low
Medium
High
0.00 0.02 0.04 0.06 0.08 0.10 0.12
Predicted Probability

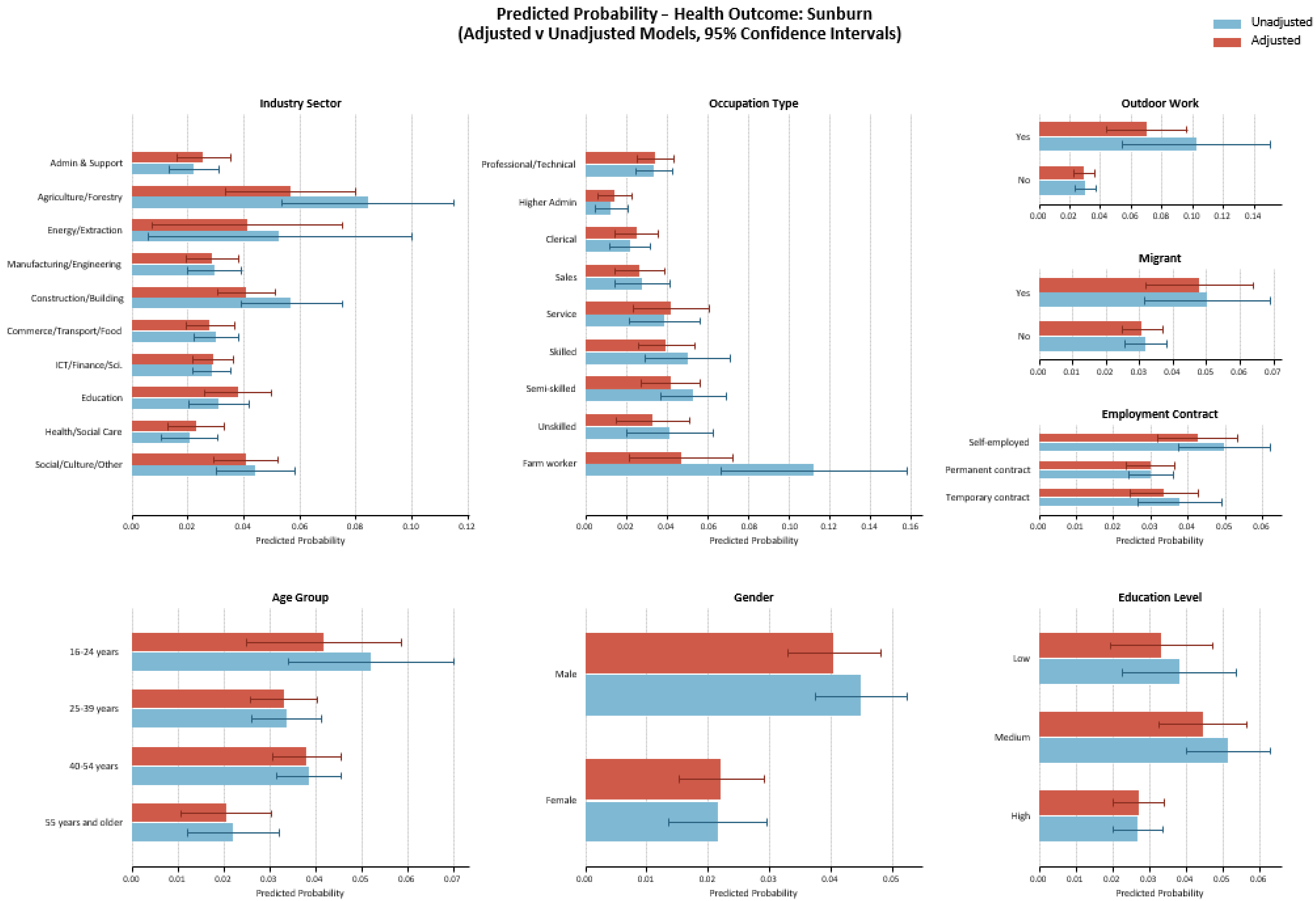

Predicted Probability – Worry about Climate-Related Preventive Measures
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
Outdoor Work
Yes
No
Migrant
Employment Contract
Self-employed
Permanent contract
Temporary contract
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
Gender
Male
Female
Education Level
Low
Medium
High



Predicted Probability – Worry about Occupational Safety & Health
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
Predicted Probability
Outdoor Work
Yes
No
Migrant
Yes
No
Employment Contract
Self-employed
Permanent contract
Temporary contract
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
Predicted Probability
Gender
Male
Female
Predicted Probability
Education Level
Low
Medium
High
Predicted Probability



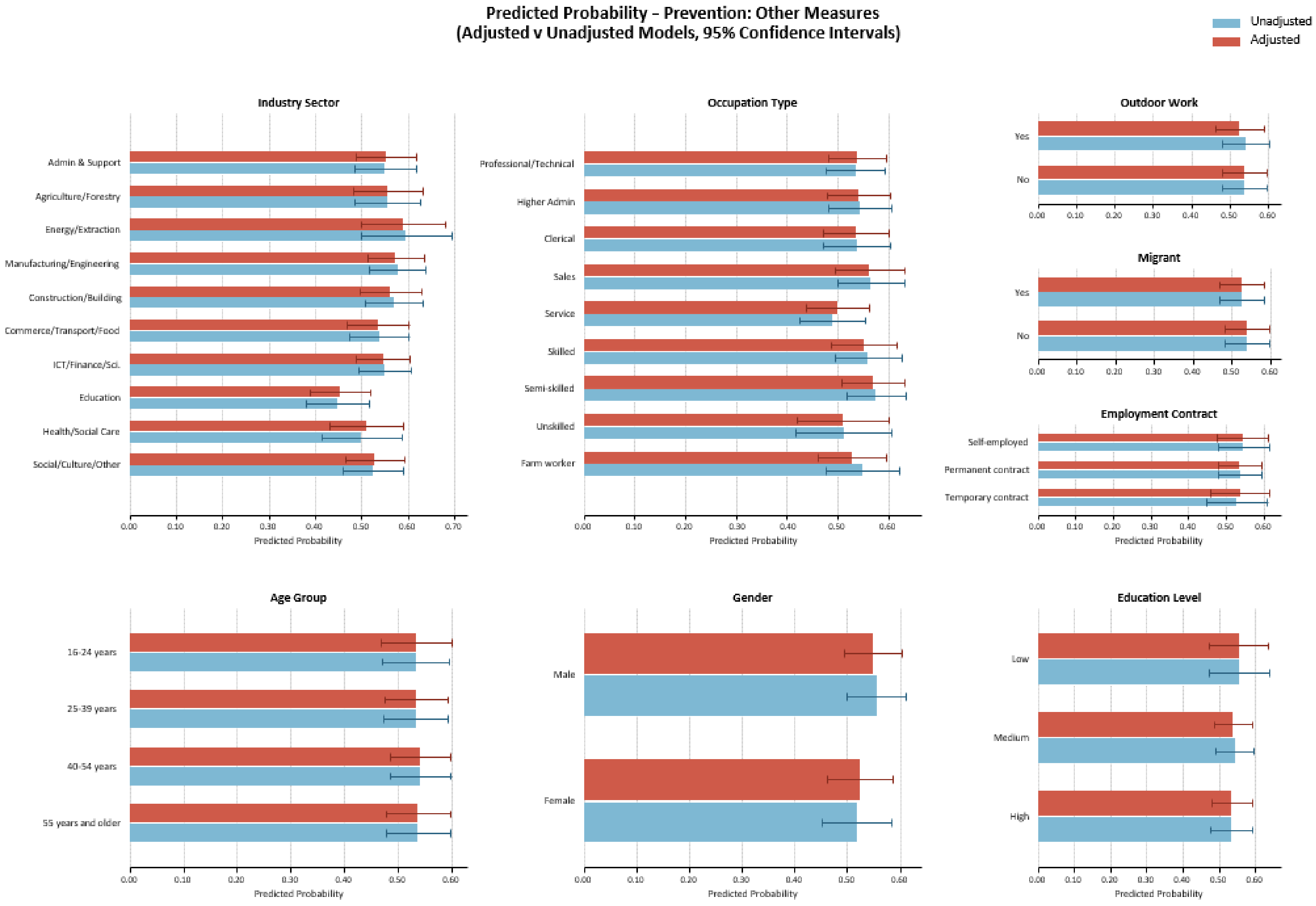
Predicted Probability – Health Outcome: Heat
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
Predicted Probability
Outdoor Work
Yes
No
Migrant
Yes
No
Employment Contract
Self-employed
Permanent contract
Temporary contract
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
Predicted Probability
Gender
Male
Female
Predicted Probability
Education Level
Low
Medium
High
Predicted Probability


Predicted Probability – Health Outcome: Sunburn
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
Predicted Probability
Outdoor Work
Yes
No
Migrant
Yes
No
Employment Contract
Self-employed
Permanent contract
Temporary contract
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
Predicted Probability
Gender
Male
Female
Predicted Probability
Education Level
Low
Medium
High
Predicted Probability


Predicted Probability – Prevention: Training
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
Predicted Probability
Outdoor Work
Yes
No
Migrant
Yes
No
Employment Contract
Self-employed
Permanent contract
Temporary contract
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
Predicted Probability
Gender
Male
Female
Predicted Probability
Education Level
Low
Medium
High
Predicted Probability

Predicted Probability – Prevention: Flexible Working
(Adjusted v Unadjusted Models, 95% Confidence Intervals)


Predicted Probability – Prevention: Consultation
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
Predicted Probability
Outdoor Work
Yes
No
Migrant
Yes
No
Employment Contract
Self-employed
Permanent contract
Temporary contract
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
Predicted Probability
Gender
Male
Female
Predicted Probability
Education Level
Low
Medium
High
Predicted Probability

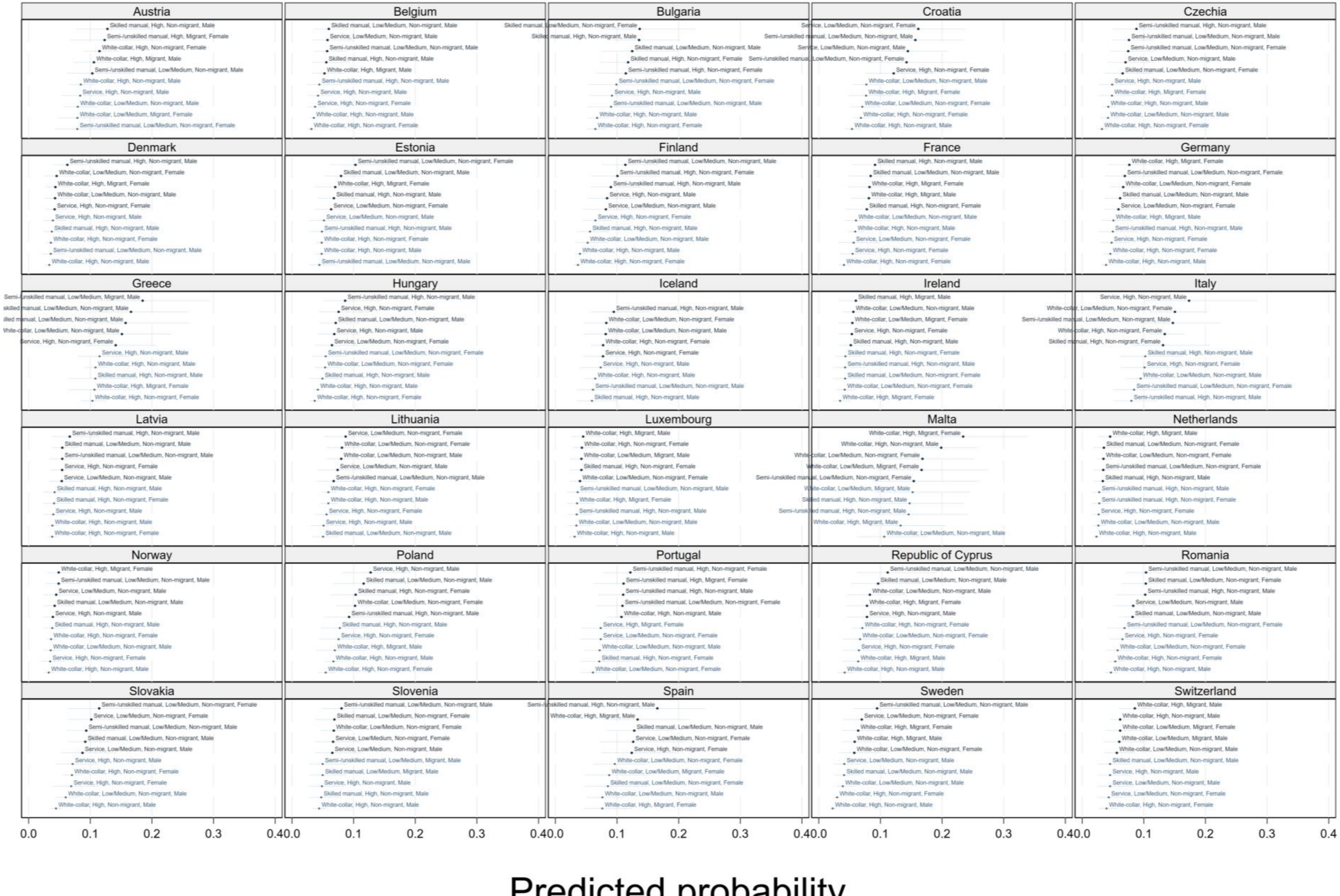


Predicted Probability – Prevention: Other Measures
(Adjusted v Unadjusted Models, 95% Confidence Intervals)
Unadjusted
Adjusted
Industry Sector
Admin & Support
Agriculture/Forestry
Energy/Extraction
Manufacturing/Engineering
Construction/Building
Commerce/Transport/Food
ICT/Finance/Sci.
Education
Health/Social Care
Social/Culture/Other
Predicted Probability
Occupation Type
Professional/Technical
Higher Admin
Clerical
Sales
Service
Skilled
Semi-skilled
Unskilled
Farm worker
Predicted Probability
Outdoor Work
Yes
No
Migrant
Yes
No
Employment Contract
Self-employed
Permanent contract
Temporary contract
Predicted Probability
Age Group
16-24 years
25-39 years
40-54 years
55 years and older
Predicted Probability
Gender
Male
Female
Predicted Probability
Education Level
Low
Medium
High
Predicted Probability

Predicted probability

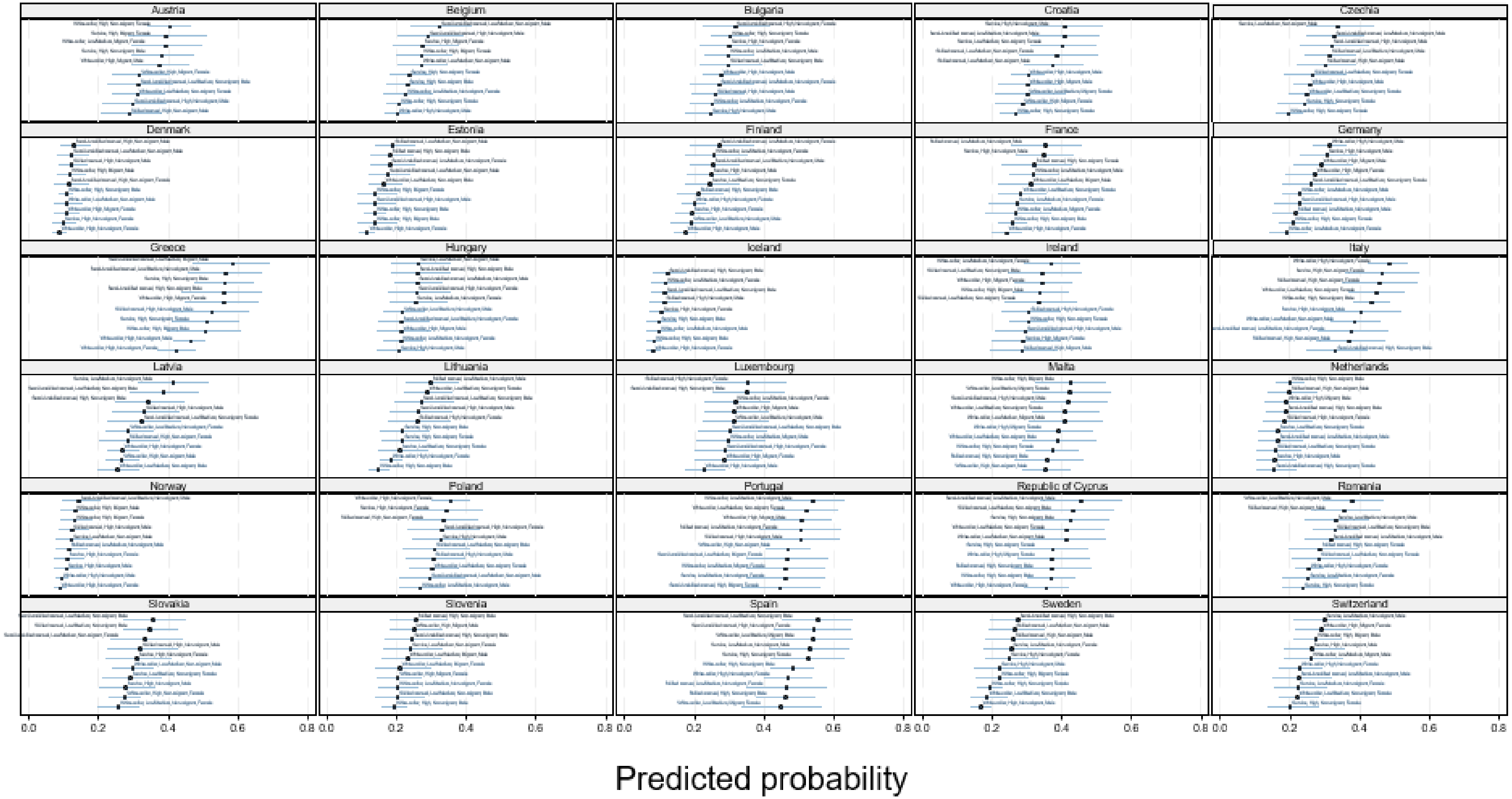
Dark = 5 highest within each country; light = 5 lowest.
Label: occupation, education, migration, gender. Cells with n<10 excluded from ranking.

Outcome: Exposure to Extreme Heat



Dark = 5 highest within each country; light = 5 lowest.
Label: occupation, education, migration, gender. Cells with n<10 excluded from ranking.

Outcome: Heat-related Illness



Dark = 5 highest within each country; light = 5 lowest.
Label: occupation, education, migration, gender. Cells with n<10 excluded from ranking.

Outcome: Worries About OSH

Authors: Claire L Niedzwiedz and Evangelia Demou (School of Health and Wellbeing, University of Glasgow, UK).

Project management: Maurizio Curtarelli and Pierre Bérastégui, European Agency for Safety and Health at Work (EU-OSHA).

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