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Interventions to protect construction workers' health from heat exposure

Submission date	**Recruitment status**	[X] Prospectively registered
11/12/2024	No longer recruiting	[_] Protocol
Registration date	**Overall study status**	[_] Statistical analysis plan
16/12/2024	Ongoing	[_] Results
Last Edited	**Condition category**	[_] Individual participant data
26/11/2025	Signs and Symptoms	[X] Record updated in last year

Plain English summary of protocol

Background and study aims
Extreme heat poses serious health risks, including heatstroke, heat stress, and mental health issues, affecting not only vulnerable groups like the elderly but also younger, active populations such as outdoor workers. These risks lead to reduced productivity, increased workplace injuries, and long-term health impacts.
In Spain, where hot summers and frequent heatwaves exacerbate these dangers, preventive measures are essential. Awareness campaigns, workplace initiatives, and updated legislation like Real Decreto 486/1997 aim to protect workers, but gaps in data and intervention effectiveness highlight the need for further research and comprehensive strategies to ensure worker safety.
The main purpose of this study is to co-create, implement and evaluate the effectiveness of a co-created intervention in mitigating the potential adverse mental and physical health effects of heat exposure among outdoor construction workers in Spain. Secondary outcomes include:
1. To co-create a new intervention, or improvements on existing policies or plans, to mitigate the adverse mental and physical health effects of heat exposure of outdoor construction workers. The intervention will be co-designed by outdoor workers, employers, and researchers.
2. To evaluate the perceptions of outdoor construction workers of heat as a health risk, as well as their knowledge and attitudes towards current recommendations and preventive policies.
3. To get a first-hand insight into the influence of culture and gender identity on the occupational behavior of workers when preventing heat exposure.
4. To characterize the exposure to heat of outdoor construction workers and the health impacts of heat exposure among outdoor construction workers, including physical and mental health outcomes.

Who can participate?
Outdoor construction workers aged over 18 years who have access to a smartphone and understand Spanish or Catalan.

What does the study involve?
This study will have two groups, an intervention group and a control group. Each participant will contribute information for 5 days.
The study will include two phases, a co-design phase and an implementation phase. In the co-design phase, workers, employers and researchers will participate in co-design activities with the

aim of designing interventions to mitigate the adverse health effects of heat exposure in the workplace, to be implemented in their own company. In the implementation phase, the company will put in place the co-designed intervention in the intervention group only, and data will be collected on heat exposure, health outcomes and compliance. The control group will carry out their normal activities according to the procedures in place in their company for the entire period.

What are the possible benefits and risks of participating?
The INTERCAMBIO project supports companies in enhancing heat prevention plans, ensuring compliance with safety regulations like Real Decreto 486, and improving worker health and productivity. It provides expert guidance, tailored co-creation sessions for practical interventions, and offers anonymity or reputational benefits for companies.
For workers, the project enables them to influence and improve workplace heat prevention measures, ensuring safer conditions. Participants benefit from health assessments and tailored interventions, with all personal data kept confidential. Participation is entirely voluntary, with no health risks or consequences for opting out, and no pressure from superiors is permitted.

Where is the study run from?
ISGlobal (Barcelona Institute for Global Health) (Spain)

When is the study starting and how long is it expected to run for?
January 2024 to December 2028

Who is funding the study?
The European Union’s Horizon Europe Research and Innovation programme under Grant Agreement No 101137149 (INTERCAMBIO)

Who is the main contact?
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Contact information

Type(s)
Public, Scientific, Principal investigator

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Additional identifiers

Protocol serial number
101137149

Study information

Scientific Title
INTERCAMBIO WP4: Interventions to promote mental and physical health in changing working environments: Outdoor construction workers

Acronym
INTERCAMBIO WP4

Study objectives
Current study objectives as of 26/11/2025:

The main purpose of this study is to co-create, implement and evaluate the effectiveness of a co-created intervention in mitigating the potential adverse mental and physical health effects of heat exposure among outdoor construction workers in Spain. Secondary objectives include:
1. To co-create a new intervention, or improvements on existing policies or plans, to mitigate the adverse mental and physical health effects of heat exposure of outdoor construction workers. The intervention will be co-designed by outdoor workers, employers, and researchers.
2. To evaluate the perceptions of outdoor construction workers on heat as a health risk, as well as their knowledge and attitudes towards current recommendations and preventive policies.
3. To get a first-hand insight of the influence of culture and gender identity on the occupational behavior of workers when preventing heat exposure.
4. To characterize the exposure to heat of outdoor construction workers and the health impacts of heat exposure among outdoor construction workers, including physical and mental health outcomes.

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Previous study objectives:

1. Workers and employers are able to suggest preventive measures that can improve existing ones in terms of protecting workers' health from the effects of heat exposure.
2. There is a sizable percentage of construction workers who do not perceive heat exposure as a health risk.
3. Gender identity and cultural background have a significant influence on the preventive behavior of workers.
4. Heat exposure is associated with the presence of heat-related illness symptoms.
5. Implementing a preventive intervention is effective in reducing the prevalence of heat-related illness symptoms.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 15/04/2025, Drug Research Ethics Committee (CEIm) (Dr. Aiguader, 88, Barcelona, 08003, Spain; +34 93 316 06 77; ceic-psmar@imim.es), ref: CEIm 2024/11887

Primary study design

Interventional

Study design
Controlled before-after intervention study (single-centre or multicentre depending on the recruited companies)

Study type(s)
Efficacy

Health condition(s) or problem(s) studied
Heat-related illness symptoms

Interventions
The study will not include randomization. All workers from the first company that accepts to participate in the intervention arm will be allocated to the intervention arm. The next company to be recruited, and their workers, will be allocated to the control arm.

The control group will carry out their normal activities according to the procedures in place in their company for the entire period. The implementation phase will run for 22 weeks, from the beginning of May 2025 to the last week of September 2025. The intervention will be implemented on the 12th week of the summer, only in the intervention arm. Thus, the intervention arm will have a before period (weeks 1-11) and an after period (weeks 12-22).

The intervention will be co-designed in collaboration with the relevant stakeholders of the study: employers, workers and occupational health scientists.

List of possible interventions:

Worker-level interventions:
1. Ask the worker to follow a specific hydration pattern during the work shift
2. Ask the worker to wear specific protective clothing (e.g. a hat or a cooling dress)
3. Use light-colored clothes (if work uniform is not provided by the company)

Company-level interventions:
1. Organize heat risk awareness campaigns or training
2. Change the schedule of activities in days of extreme heat
3. Impose mandatory rest periods
4. Engineering improvements in the workplace, e.g. to increase shade
5. Introduce strategies to improve worker’s hydration
6. Provide ice slurry for workers
7. Provide cooling dressing for workers as part of their PPE

Intervention Type
Behavioural

Primary outcome(s)
1. Heat-related illness symptoms measured using the Heat Illness Symptom Index at the end of the work shift using a validated scale that rates 11 symptoms (e.g., fatigue, cramps, dizziness) from 0 (no symptoms) to 10 (symptoms requiring cessation of work).

2. Average skin temperature during the shift will be monitored using four iButton devices placed at specific body locations (neck, scapula, hand, and shin) and calculated as a weighted average based on established guidelines.

Key secondary outcome(s)

Current key secondary outcome(s) as of 26/11/2025:

1. Prevalence of individual heat-related illness symptoms (feeling tired, cramps, nausea, dizziness, thirst, vomiting, confusion, muscle weakness, heat sensations on the head or neck, chills, and feeling lightheaded) during each work shift. Variables will be dichotomized as less than 3 or greater or equal than 3 (presence of symptoms). If the frequencies are not too low, the researchers will also dichotomize at the value of 5 (presence of moderate or severe symptoms).
2. Cognitive performance will be measured at the end of each work shift based on the Stroop test: 1) response time in milliseconds in the incongruent trials; 2) number of correct responses per minute; 3) inhibitory control, calculated as the difference between mean incongruent and congruent reaction time.
3. Self-reported sleepiness measured using the Karolinska Sleepiness Scale (KSS) at the end of the work shift
4. Sleep parameters obtained from Axivity (Ax3) sensor: sleep duration, sleep efficiency, awakenings, and wake after sleep onset. Sleep duration will be calculated as the duration between sleep onset and termination. Sleep efficiency will be defined as the proportion of time spent sleeping from onset to termination: (sleep duration–wake after sleep onset)/sleep duration. Sleep efficiency ranges from 0 to 1, where a score of 1 means the individual did not wake between sleep onset and termination. Awakenings were defined as the number of times a person was awake >5 minutes during the sleep period. Wake after sleep onset will be defined as the sum of the time a person was awake between sleep onset and sleep termination.
5. Time in moderate-to-vigorous physical activity at ambient temperatures greater than 28°C will be measured with the data provided by the accelerometer (physical activity) and the Wet Bulb Globe Temperature (ambient temperature) throughout the whole of the participation.
6. Perceived exertion (RPE) at the end of the shift measured using a scale: Not tired at all (0) - Extremely tired (almost maximal) (10)
7. Thermal sensation during the work shift (TS) will be self-reported by participants every day at the end of the work shift on a scale from 1 (cold) to 7 (hot)
8. Hydration frequency measured with the self-reported amount of liters of liquid ingested by participants during their work shift on a daily basis.
9. Hydration status will be analyzed measuring the urine specific gravity (UG) from urine samples. Also, self-reported urine color on a scale at the end of the work shift will be provided by participants.
10. Perception of heat as a risk for health is measured with a baseline questionnaire at the beginning of the participation.
11. Perceptual Strain Index (PeSI) during work shift, calculated every day of participation, will be calculated based on the previously mentioned parameters (RPE: Perceived Extertion, TS: Thermal sensation) PeSI = 0.5*RPE + 5*(TS-1)/6), which will then be rescaled from 0 to 10.
12. Stress levels and mood measured at the end of the work shift with self-reported questions using a visual analogue scale from 0 to 100.

Previous key secondary outcome(s):

1. Prevalence of individual heat-related illness symptoms (feeling tired, cramps, nausea, dizziness, thirst, vomiting, confusion, muscle weakness, heat sensations on the head or neck,

chills, and feeling lightheaded) during each work shift. Variables will be dichotomized as less than 3 or greater or equal than 3 (presence of symptoms). If the frequencies are not too low, the researchers will also dichotomize at the value of 5 (presence of moderate or severe symptoms).
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7. Thermal sensation during the work shift (TS) will be self-reported by participants every day at the end of the work shift on a scale from 1 (cold) to 7 (hot)
8. Hydration frequency measured with the self-reported amount of liters of liquid ingested by participants during their work shift on a daily basis.
9. Hydration status will be measured with the self-reported urine color on a scale at the end of the work shift.
10. Perception of heat as a risk for health is measured with a baseline questionnaire at the beginning of the participation.
11. Perceptual Strain Index (PeSI) during work shift, calculated every day of participation, will be calculated based on the previously mentioned parameters (RPE: Perceived Extertion, TS: Thermal sensation) PeSI = 0.5*RPE + 5*(TS-1)/6), which will then be rescaled from 0 to 10.
12. Stress levels and mood measured at the end of the work shift with self-reported questions using a visual analogue scale from 0 to 100.
13. Heart rate variability during the work shift, obtained from the Polar H10 sensor that will be worn during the work shift.

Completion date
30/12/2028

Eligibility

Key inclusion criteria
1. Participants must be over 18 years
2. Participants must have access to a smartphone

Participant type(s)
Employee, Healthy volunteer

Healthy volunteers allowed

No

Age group
Mixed

Lower age limit
18 Years

Upper age limit
67 Years

Sex
All

Total final enrolment
0

Key exclusion criteria
Not being able to understand Catalan, Spanish or English

Date of first enrolment
01/01/2025

Date of final enrolment
01/08/2026

Locations

Countries of recruitment
Spain

Study participating centre
ISGlobal (Barcelona Institute for Global Health)
Campus Mar
C/ Doctor Aiguader, 88
Barcelona
Spain
08003

Sponsor information

Organisation
Fundacion Privada Instituto De Salud Global Barcelona

Funder(s)

Funder type
Government

Funder Name
The European Union’s Horizon Europe Research and Innovation programme under Grant Agreement No 101137149 (INTERCAMBIO)

Results and Publications

Individual participant data (IPD) sharing plan
The datasets generated during and/or analysed during the current study will be stored in a publicly available repository. Anonymised data will be published in the INTERCAMBIO ISGlobal Dataverse data repository, except when there is risk of re-identification of participants

IPD sharing plan summary
Stored in publicly available repository

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Study website	Study website	11/11/2025	11/11/2025	No	Yes