Roma, 23 marzo 2023

Alessandro Marinaccio

WORKLIMATE
CLIMA LAVORO PREVENZIONE

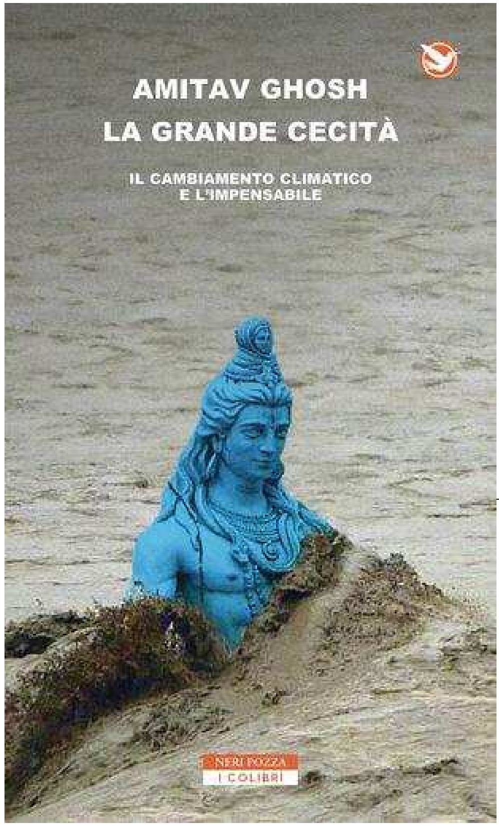
INAIL

Convegno: CAMBIAMENTI CLIMATICI ED IMPATTI SULLA SALUTE E SICUREZZA DEI LAVORATORI, il progetto Worklimate.

Consiglio Nazionale delle Ricerche
INAIL ISTITUTO NAZIONALE PER L'ASSICURAZIONE CONTRO GLI INFORTUNI SUL LAVORO
SST Azienda USL Toscana centro Servizio Sanitario della Toscana
SST Azienda USL Toscana sud est Servizio Sanitario della Toscana
D/EP/ Lazio
CONSORZIO LaMMA

Salute e sicurezza nei luoghi di lavoro, impatti del cambiamento climatico e delle ondate di calore

Cambiamento climatico



I cambiamenti climatici sono l'entità che definisce la nostra epoca: eterei, si muovono su scala planetaria, hanno degli impatti enormi sul nostro modo di vivere e di pensare; la loro presenza è pervasiva ma difficile da afferrare fino in fondo.

"La nostra era verrà definita l'epoca della Grande Cecità»

Amitav Ghosh. La grande cecità. Neri Pozza editore, 2017

Cambiamento climatico, salute e sicurezza nei luoghi di lavoro. NIOSH

"A number of both indoor and outdoor worker populations may be particularly vulnerable to climate variations."

"Climate related occupational hazards include high temperatures, air pollution, extreme weather and natural disasters, and biological hazards."

Promoting productive workplaces through safety and health research / NIOSH

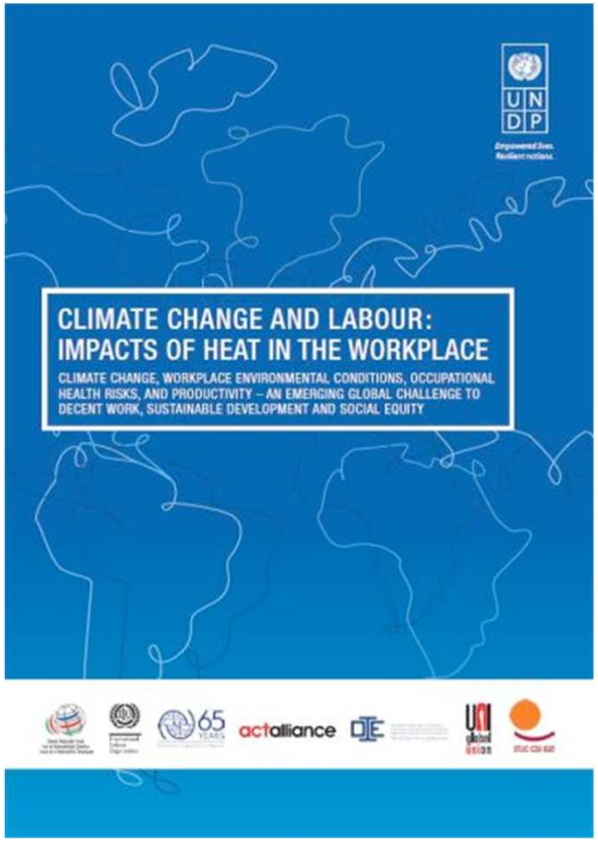
Occupational Safety and Health and Climate

Print

Variation in temperature, precipitation, wind, or other type of weather have the potential to affect human health in several direct and indirect ways. The challenge is to research and characterize how these climate conditions may influence worker health and safety and to establish plans for mitigating, responding to, and adapting to current and anticipated health impacts.

NIOSH, Promoting productive workplaces through research. NIOSH website, topic, climate

Cambiamento climatico, esposizione al caldo, salute e sicurezza nei luoghi di lavoro. Linee Guida ILO, OMS, UN



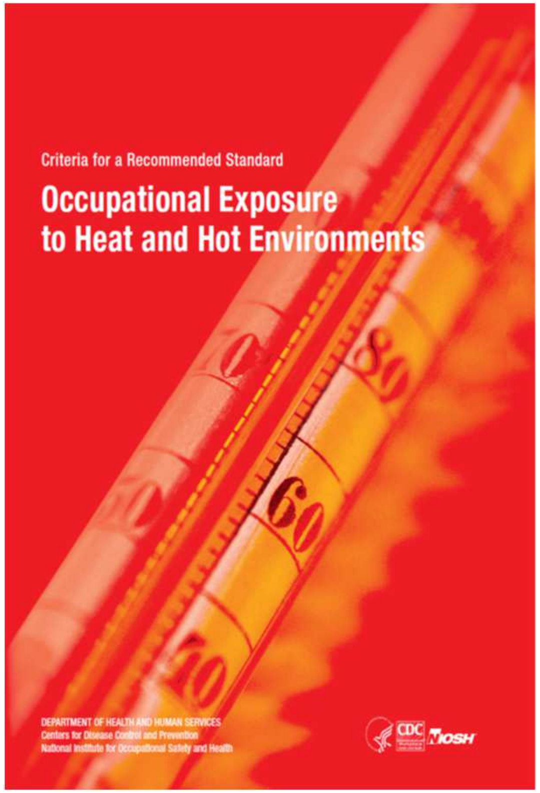
- The lowest income-bracket work – heavy labour and low-skill agricultural and manufacturing jobs – are among the most susceptible to climate change.

- Since November 2015, the ILO adopted Guidelines for governments and other labour organizations to address the health and safety ramifications of climate change. But no international organization has established a programme to assist countries vulnerable to the challenges of climate change for the workplace.

- Actions are needed to protect workers and employers now and in the future, including low cost measures such as assured access to drinking water in workplaces, frequent rest breaks, and management of output targets, carried out with protection of income and other conditions of Decent Work.

Climate Vulnerable Forum, UNDP, ILO, WHO, IOM, IOE, UNI Global Union, 2016

Cambiamento climatico, esposizione al caldo, salute e sicurezza nei luoghi di lavoro. Linee Guida NIOSH, HSE



HSE
Health and Safety Executive

Heat stress in the workplace

A brief guide

This leaflet describes what you, as an employer, may need to do to protect your employees from heat stress in the workplace. It will also be useful to employees and their safety representatives.

It tells you about the risks to the body from overheating when working in hot conditions (such as bakeries, compressed air tunnels, foundries and smelting operations) and gives practical guidance on how to avoid it. It does not address issues of thermal comfort in the workplace.

If you need more information on workplace temperature management than is provided here then visit our web pages on heat stress risk assessment (www.hse.gov.uk/temperature/heatstress/riskassessment.htm) and heat stress measurement (www.hse.gov.uk/temperature/heatstress/index.htm).

In many jobs heat stress is an issue all year round but this information also applies during the hot summer months where there may be an increased risk of heat stress for some people.

This is a web-friendly version of leaflet INDG451(rev1), published 06/13

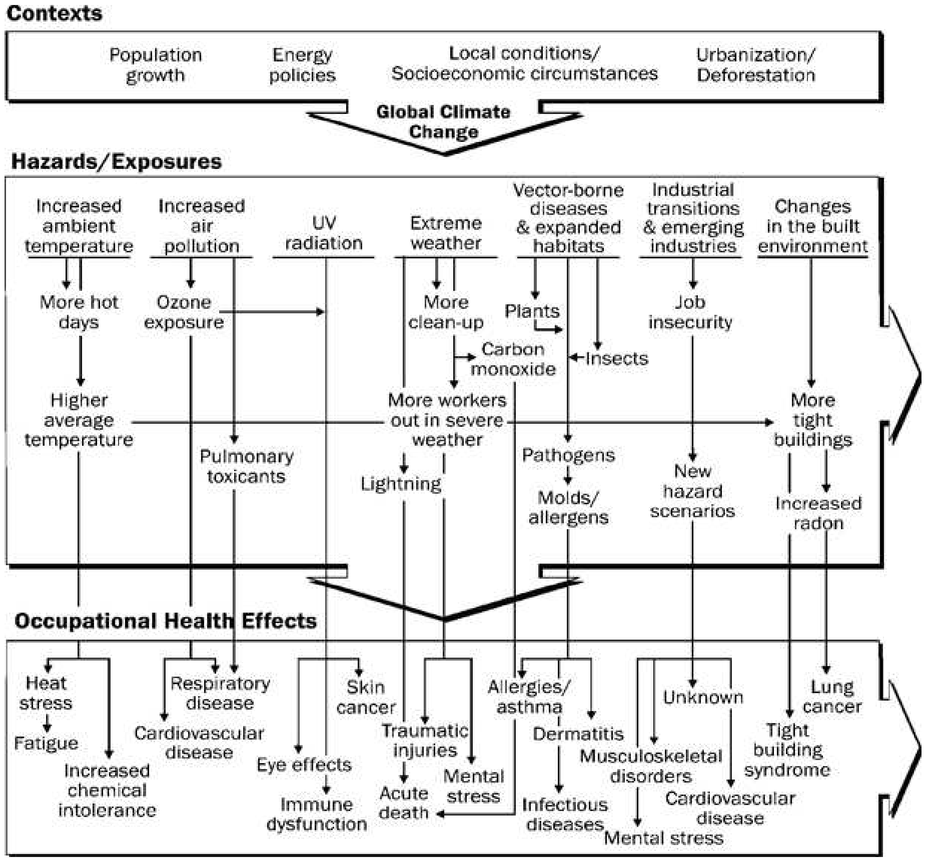
NIOSH. Criteria for a Recommended Standard Occupational Exposure to Heat and Hot Environments, 2016
HSE. Heat stress in the workplace. A brief guide, 2013

Cambiamento climatico, salute e sicurezza nei luoghi di lavoro. Ricerca scientifica

Advancing the framework for considering the effects of climate change on worker safety and health

P.A. Schulte[a], A. Bhattacharya[a], C.R. Butler[b], H.K. Chun[c], B. Jacklitsch[a], T. Jacobs[d], M. Kiefer[b], J. Lincoln[e], S. Pendergrass[a], J. Shire[d], J. Watson[f], and G.R. Wagner[g]

- ✓ Increased temperature;
- ✓ Increased air pollution;
- ✓ UV radiation;
- ✓ Extreme events;
- ✓ Vector-borne diseases;
- ✓ Industrial transition and emerging sectors;



Schulte, P.A., and H. Chun: Climate change and occupational safety and health: establishing a preliminary framework. J Occup Environ Hyg. 6(9):542–554 (2009).

INAIL

Cambiamento climatico, esposizione al caldo, salute e sicurezza nei luoghi di lavoro. Ricerca scientifica

JOURNAL OF OCCUPATIONAL AND ENVIRONMENTAL HYGIENE
2016, VOL. 13, NO. 11, 847–865
http://dx.doi.org/10.1080/15459624.2016.1179388

Advancing the framework for considering the effects of climate change on worker safety and health

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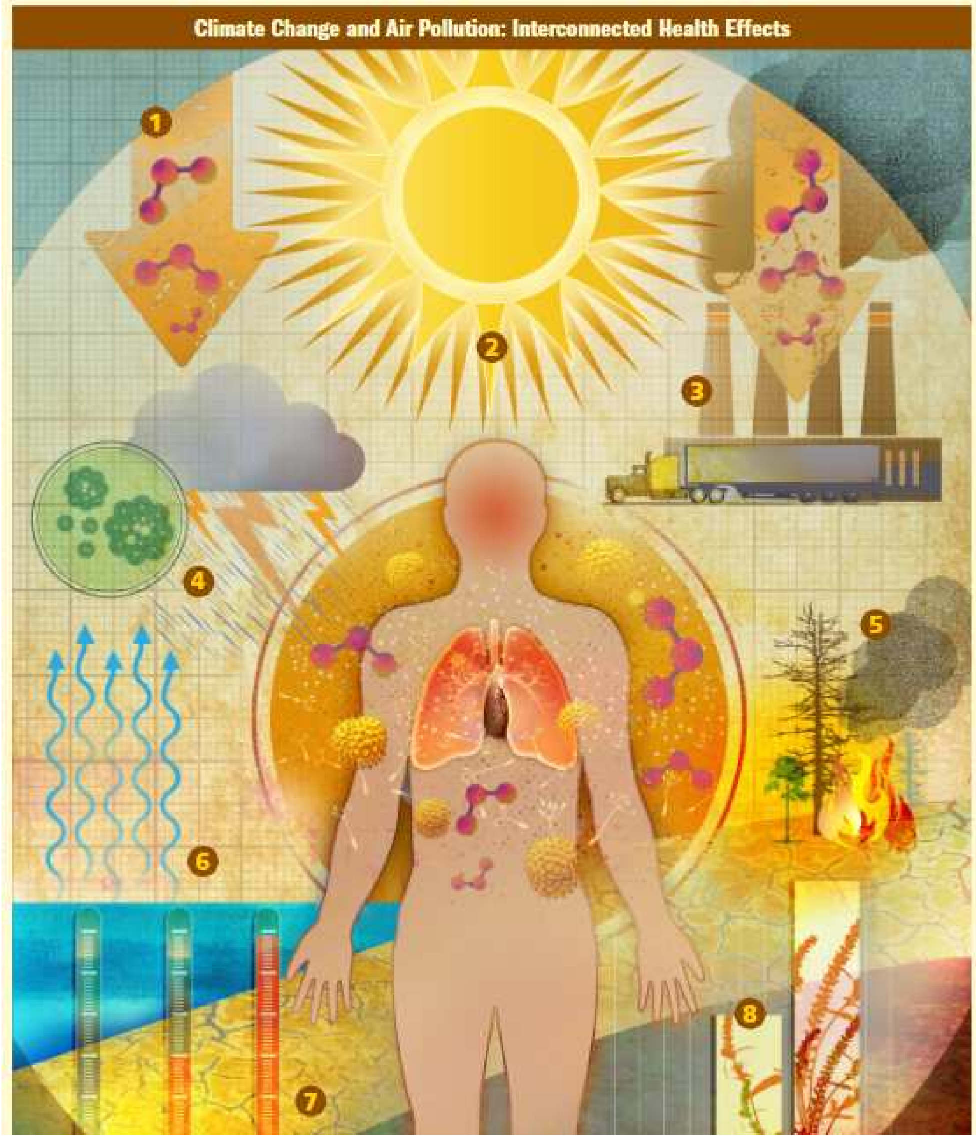
- ✓ Aumento delle temperature outdoor (progetto WORKLIMATE);
- ✓ Inquinamento dell’aria;
- ✓ Esposizione a radiazioni ultraviolette;
- ✓ Eventi climatici estremi;
- ✓ Malattie trasmissibili e rischio da agenti biologici;
- ✓ Transizione ecologica e tecnologie emergenti;
- ✓ Energie rinnovabili.

Cambiamento climatico, esposizione al caldo, salute e sicurezza nei luoghi di lavoro. Ricerca scientifica, inquinamento

"Air pollution and climate change have complex interrelationships. In a reciprocal interplay, various air pollutants increase global warming and global warming leads to formation of various pollutants."

- ✓ Incremento di alta pressione atmosferica;
- ✓ Incremento di esposizione ad Ozono;
- ✓ Rischio di eventi estremi (incendi boschivi);

  - ✓ Contesti occupazionali;
  - ✓ Lavoratori delle emergenze;
  - ✓ Lavoratori outdoor.



INAIL

Cambiamento climatico, esposizione al caldo, salute e sicurezza nei luoghi di lavoro. Ricerca scientifica, malattie trasmissibili da agenti biologici

"There is a real concern regarding the impact of climate change on vector-borne disease and other biological hazards (venomous insects and reptiles, water-borne disease, non-vector-borne pathogens, and poisonous plants)."

"Outdoor workers are primarily at risk, including those in construction, landscaping, forestry, brush clearing, land surveying, farming, oil field and utility work, natural resources management, and wildland firefighters".

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Cambiamento climatico, esposizione al caldo, salute e sicurezza nei luoghi di lavoro. Ricerca scientifica

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«Research needs, Surveillance.»

«Identify injuries, illnesses, and death on hot days»

Table 1. Framework for climate change and occupational safety and health.

	Research Needs			
Climate-related Occupational Hazards	Research	Surveillance	Risk Assessment	Risk Management
Increased ambient temperature	• Investigate PPE for use in hot/humid environments • Assess the economic burden of heat influence on worker health and productivity	• Identify geographic range of heat hazards • Identify injuries, illnesses, and deaths on hot days	• Determine risks of toxic and safety effects of chemicals in hot environments • Identify the interaction of various susceptibility factors and heat hazards	• Target heat illness prevention in manual workers • Assess return on investment on interventions • Develop heat stress awareness and education for employers and workers

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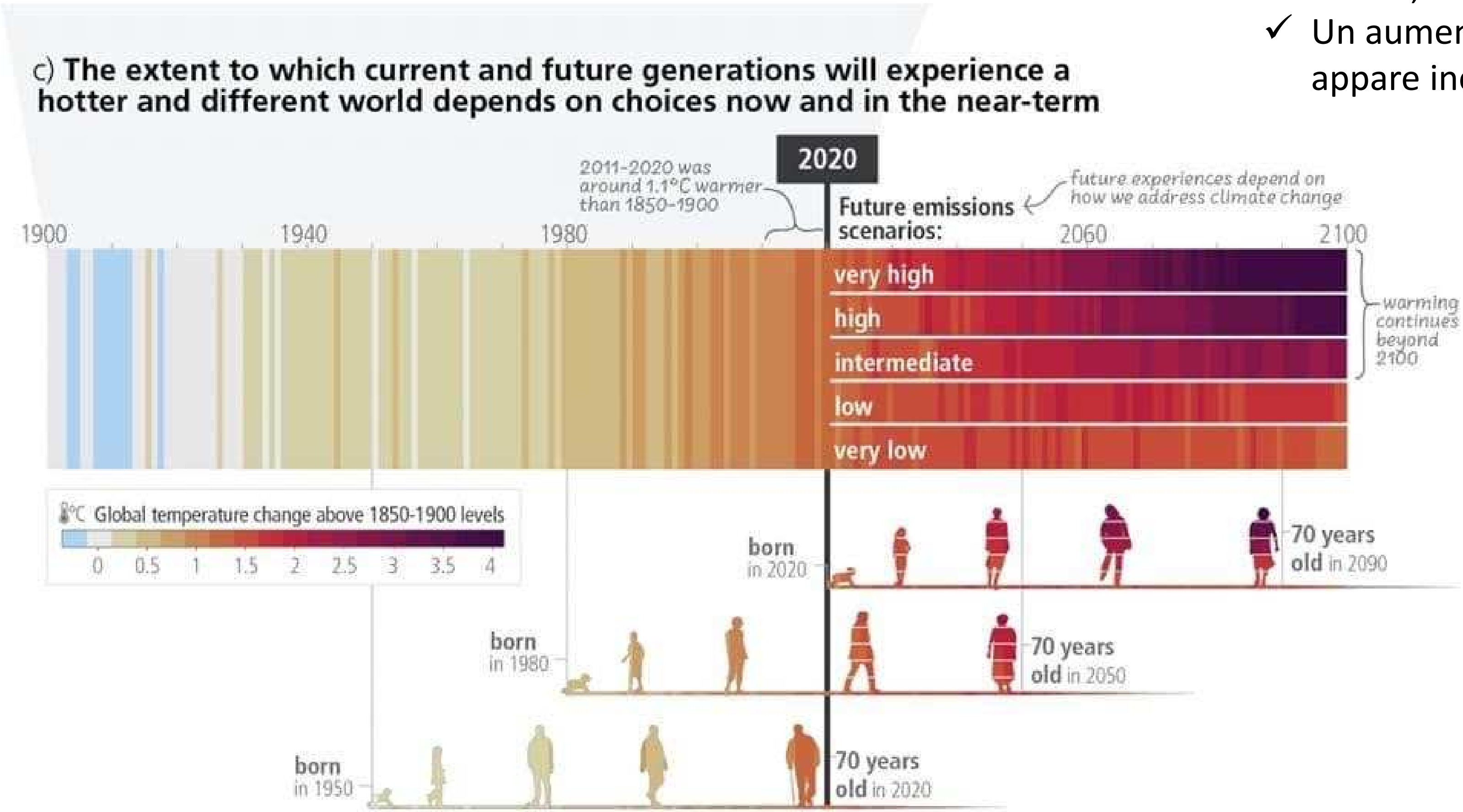
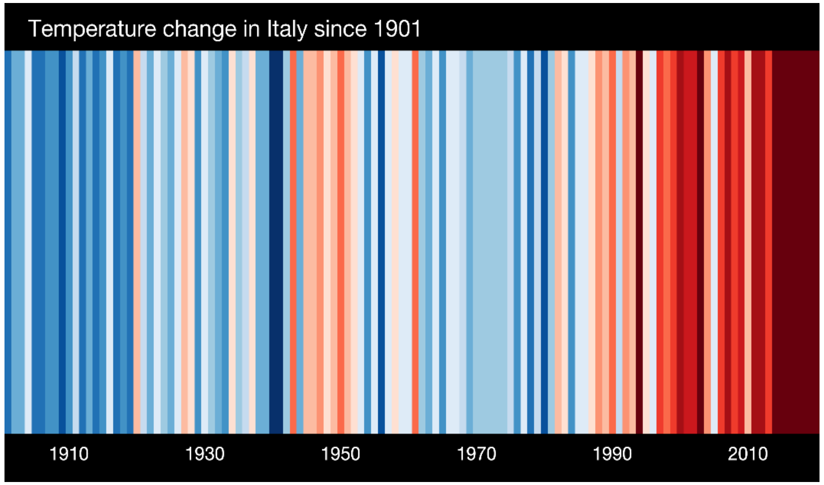
Cambiamento climatico, IPCC 2023 Report
Aumento della temperatura

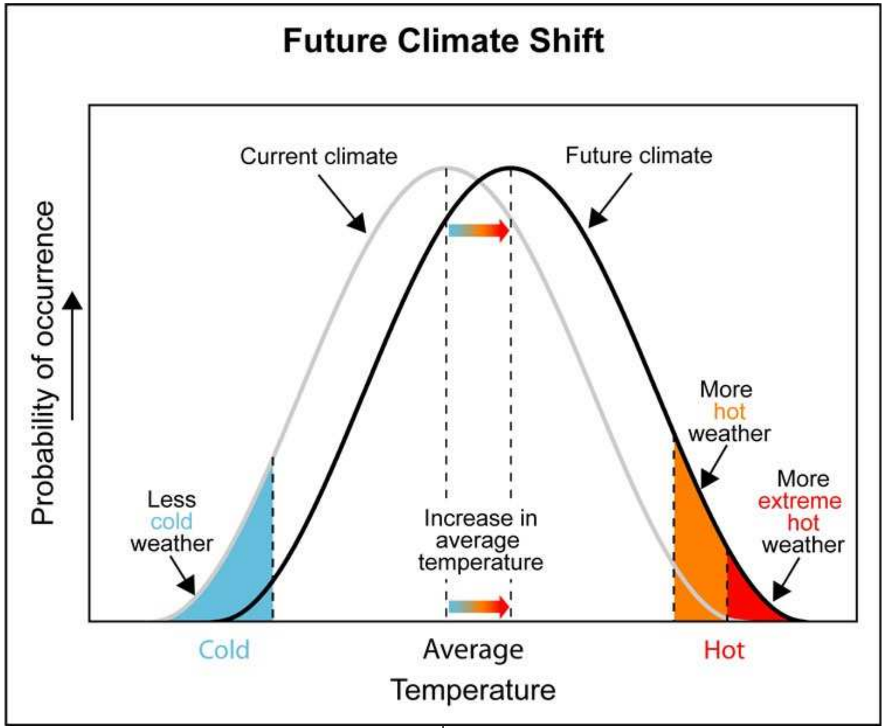


IPCC 2023

- ✓ Gli scenari dipendono dalle scelte attuali;
- ✓ Un aumento delle temperature appare inevitabile.

Cambiamento climatico, IPCC 2023 Report
Ondate di calore





- ✓ E' largamente condivisa la previsione di un aumento di intensità e durata delle ondate di calore;
- ✓ Si tratta di uno scenario poco reversibile nel breve periodo;
- ✓ IPCC Report 2022 sottolinea questa specifica criticità per l'Europa meridionale e l'Italia.

Revisione sistematica degli studi epidemiologici di analisi della correlazione fra temperature ed infortuni.

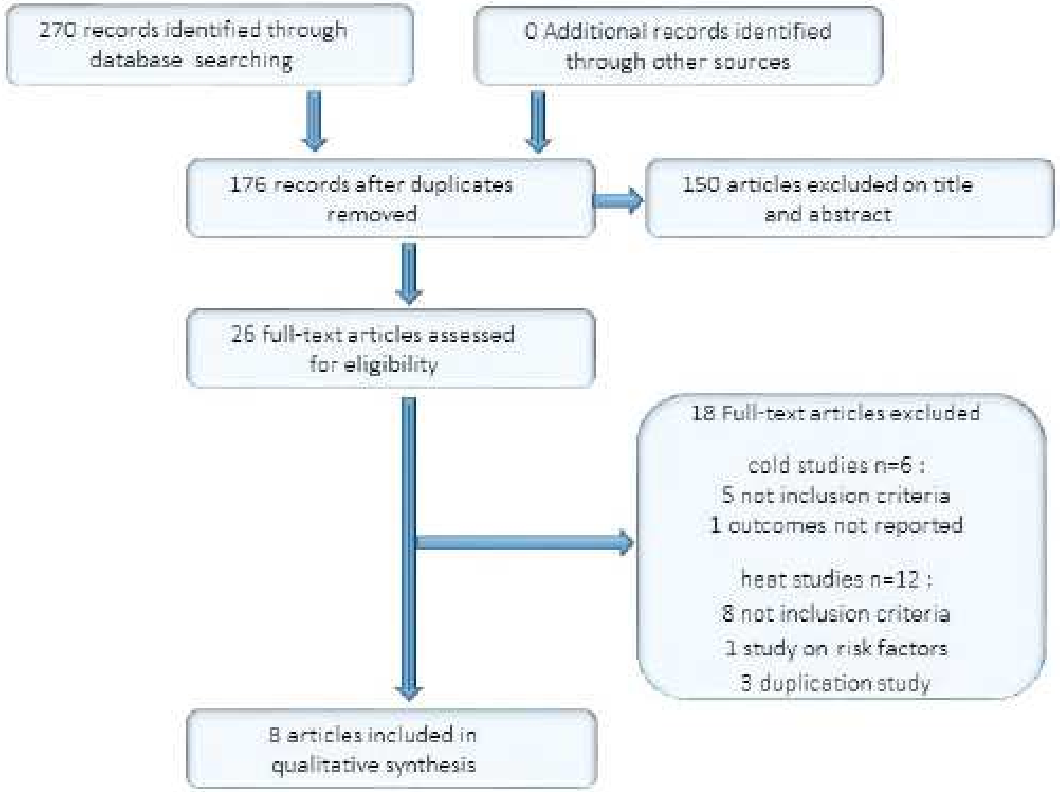
The association between extreme weather conditions and work-related injuries and diseases. A systematic review of epidemiological studies

Michela Bonafede[1], Alessandro Marinaccio[1], Federica Asta[2], Patrizia Schifano[2], Paola Michelozzi[2] and Simona Vecchi[2]

[1]*Dipartimento di Medicina, Epidemiologia e Igiene del Lavoro e Ambientale, Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro (INAIL), Rome, Italy*
[2]*Dipartimento di Epidemiologia del Servizio Sanitario Regionale, Regione Lazio, Rome, Italy*

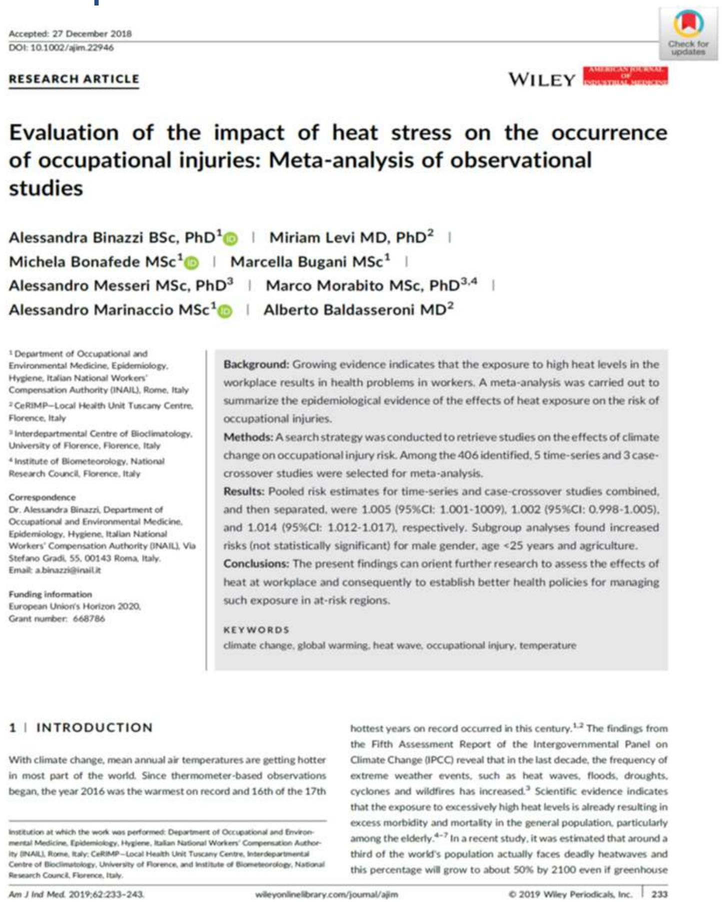
Abstract
Introduction. The relationship between extreme temperature and population health has been well documented. Our objective was to assess the evidence supporting an association between extreme temperature and work related injuries.
Methods. We carried out a systematic search with no date limits using PubMed, the Cochrane central register of controlled trials, EMBASE, Web of Science and the internet sites of key organizations on environmental and occupational health and safety. Risk of bias was evaluated with Cochrane procedure.
Results. Among 270 studies selected at the first step, we analyzed 20 studies according to inclusion criteria (4 and 16 referring to extreme cold and heat temperature, respectively).
Discussion. Despite the relevance for policy makers and for occupational safety authorities, the associations between extreme temperature and work related injuries is seldom analyzed. The estimation of risk, the identification of specific jobs involved and the characterization of the complex mechanisms involved could help to define prevention measures.

Key words
- occupational health
- occupational injuries
- climate change
- environmental health
- temperature



Fonte: Bonafede M et al. Ann Ist Super Sanita. 2016 Jul-Sep;52(3):357-367.

Metanalisi degli studi epidemiologici di analisi di associazione fra esposizione a temperature estreme e rischio di infortuni sul lavoro



Accepted: 27 December 2018
DOI: 10.1002/ajim.22946

RESEARCH ARTICLE

WILEY AMERICAN JOURNAL OF INDUSTRIAL MEDICINE

Evaluation of the impact of heat stress on the occurrence of occupational injuries: Meta-analysis of observational studies

Alessandra Binazzi BSc, PhD[1] | Miriam Levi MD, PhD[2] | Michela Bonafede MSc[1] | Marcella Bugani MSc[1] | Alessandro Messeri MSc, PhD[3] | Marco Morabito MSc, PhD[3,4] | Alessandro Marinaccio MSc[1] | Alberto Baldasseroni MD[2]

[1] Department of Occupational and Environmental Medicine, Epidemiology, Hygiene, Italian National Workers' Compensation Authority (INAIL), Rome, Italy
[2] CeRIMP—Local Health Unit Tuscany Centre, Florence, Italy
[3] Interdepartmental Centre of Bioclimatology, University of Florence, Florence, Italy
[4] Institute of Biometeorology, National Research Council, Florence, Italy

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Funding information
European Union's Horizon 2020, Grant number: 668786

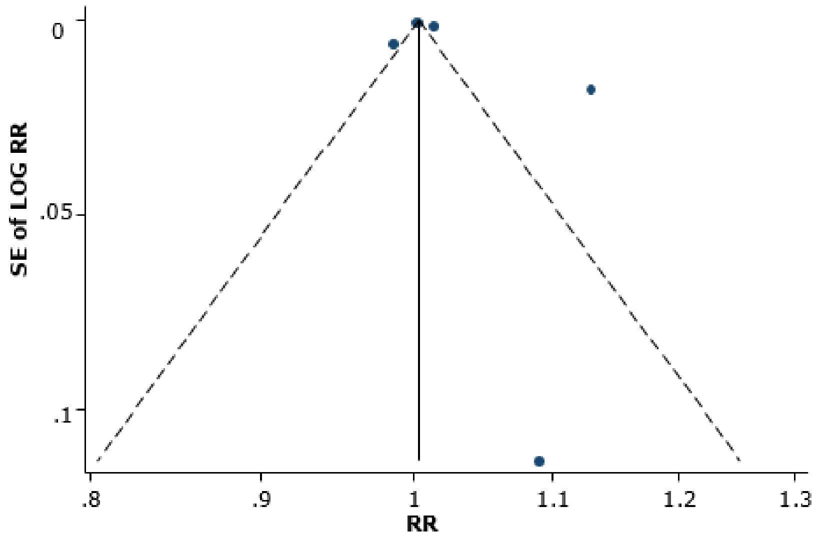
Background: Growing evidence indicates that the exposure to high heat levels in the workplace results in health problems in workers. A meta-analysis was carried out to summarize the epidemiological evidence of the effects of heat exposure on the risk of occupational injuries.
Methods: A search strategy was conducted to retrieve studies on the effects of climate change on occupational injury risk. Among the 406 identified, 5 time-series and 3 case-crossover studies were selected for meta-analysis.
Results: Pooled risk estimates for time-series and case-crossover studies combined, and then separated, were 1.005 (95%CI: 1.001-1009), 1.002 (95%CI: 0.998-1.005), and 1.014 (95%CI: 1.012-1.017), respectively. Subgroup analyses found increased risks (not statistically significant) for male gender, age <25 years and agriculture.
Conclusions: The present findings can orient further research to assess the effects of heat at workplace and consequently to establish better health policies for managing such exposure in at-risk regions.

KEYWORDS
climate change, global warming, heat wave, occupational injury, temperature

1 | INTRODUCTION

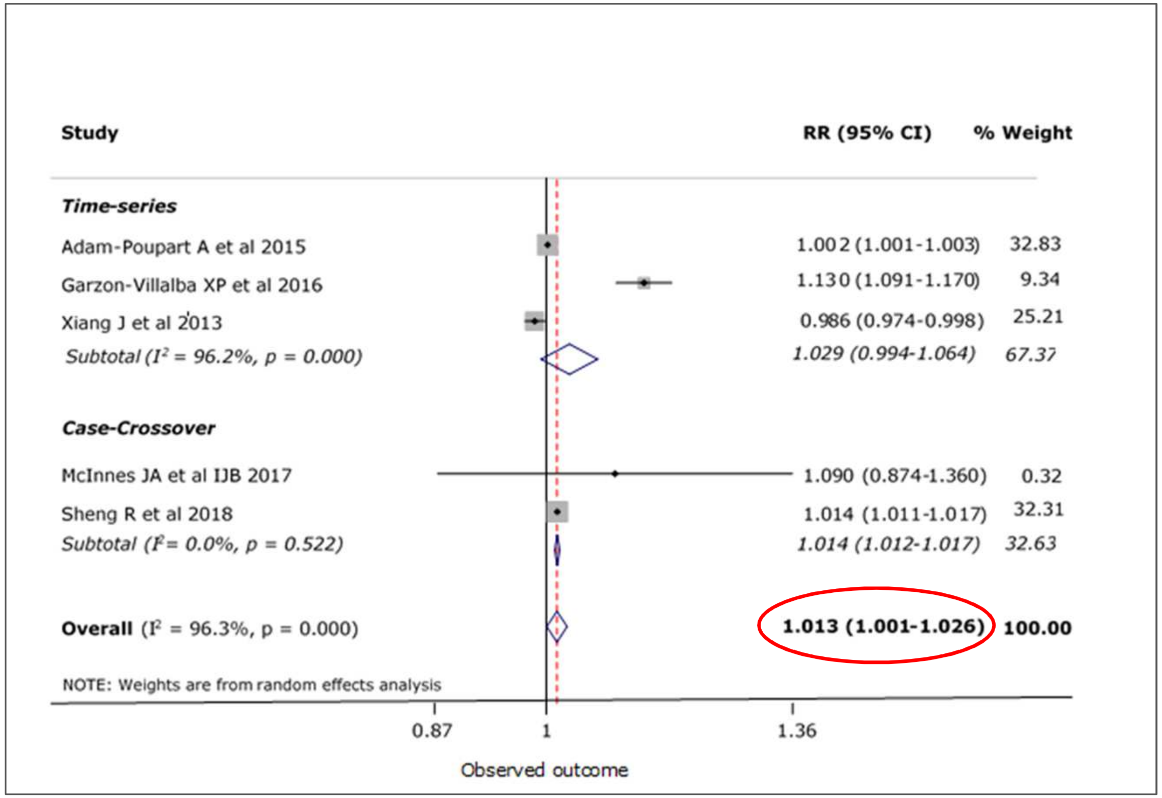
With climate change, mean annual air temperatures are getting hotter in most part of the world. Since thermometer-based observations began, the year 2016 was the warmest on record and 16th of the 17th hottest years on record occurred in this century.[1,2] The findings from the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) reveal that in the last decade, the frequency of extreme weather events, such as heat waves, floods, droughts, cyclones and wildfires has increased.[3] Scientific evidence indicates that the exposure to excessively high heat levels is already resulting in excess morbidity and mortality in the general population, particularly among the elderly.[4-7] In a recent study, it was estimated that around a third of the world's population actually faces deadly heatwaves and this percentage will grow to about 50% by 2100 even if greenhouse

Institution at which the work was performed: Department of Occupational and Environmental Medicine, Epidemiology, Hygiene, Italian National Workers' Compensation Authority (INAIL), Rome, Italy; CeRIMP—Local Health Unit Tuscany Centre, Interdepartmental Centre of Bioclimatology, University of Florence, and Institute of Biometeorology, National Research Council, Florence, Italy.



Binazzi A et al. Am J Ind Med. 2019 Mar;62(3):233-243.

Metanalisi degli studi epidemiologici di analisi di associazione fra esposizione a temperature estreme e rischio di infortuni sul lavoro



Evaluation of the impact of heat stress on the occurrence of occupational injuries: Meta-analysis of observational studies

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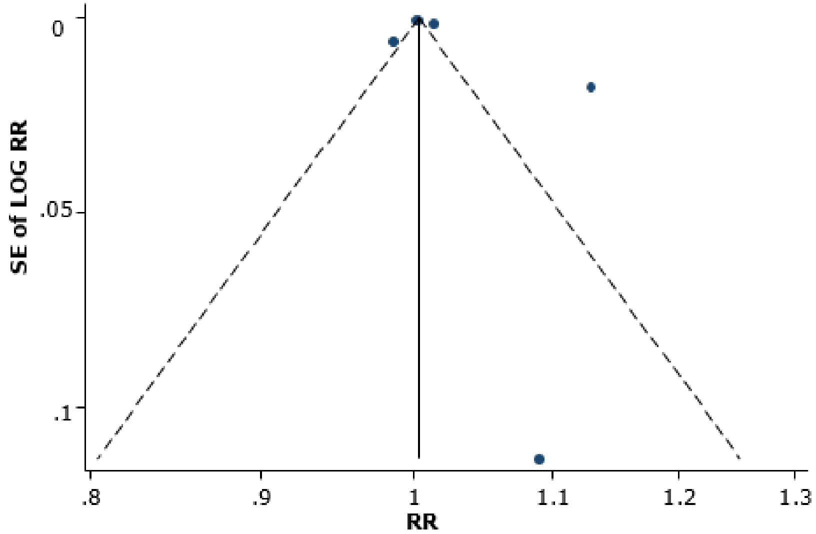


Binazzi A et al. Am J Ind Med. 2019 Mar;62(3):233-243.

Metanalisi degli studi epidemiologici di analisi di associazione fra esposizione a temperature estreme e rischio di infortuni sul lavoro. Fatima et al.

Environment International 148 (2021) 106384

Contents lists available at ScienceDirect

Environment International

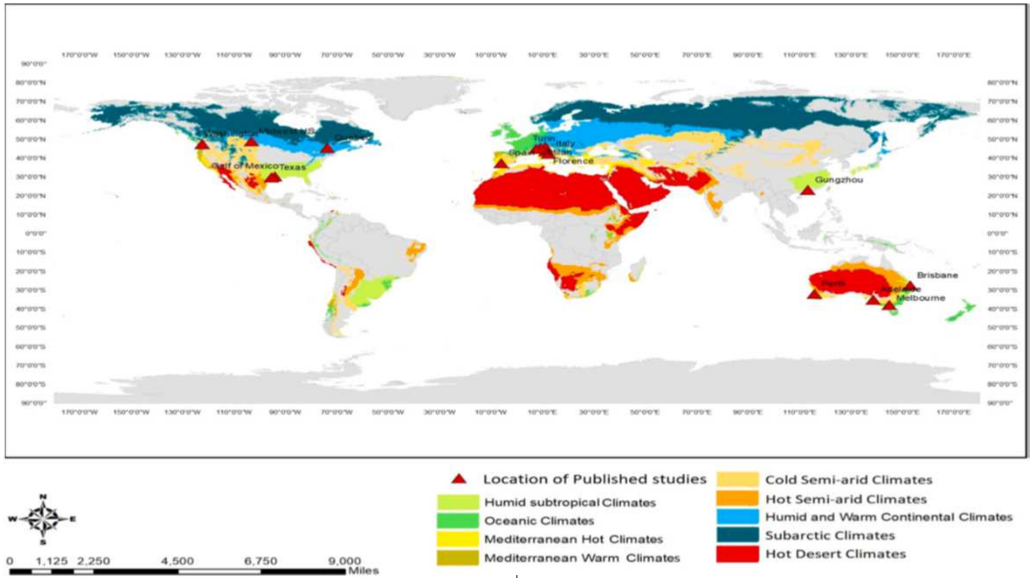
journal homepage: www.elsevier.com/locate/envint

Review article

Extreme heat and occupational injuries in different climate zones: A systematic review and meta-analysis of epidemiological evidence

Syeda Hira Fatima [a], Paul Rothmore [b], Lynne C. Giles [a], Blesson M. Varghese [a], Peng Bi [a,*]

[a] School of Public Health, The University of Adelaide, Australia
[b] School of Allied Health Science and Practice, The University of Adelaide, Australia



"The pooled results suggested that the risk of occupational injuries increased by 1% for 1 °C increased in temperature. Young workers, male and workers in agriculture, construction and manufacturing were at major risk."

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Fatima SH, et al. Extreme heat and occupational injuries in different climate zones: A systematic review and meta-analysis of epidemiological evidence. Environ Int. 2021 Mar;148:106384.

Cambiamento climatico e impatti sulla salute

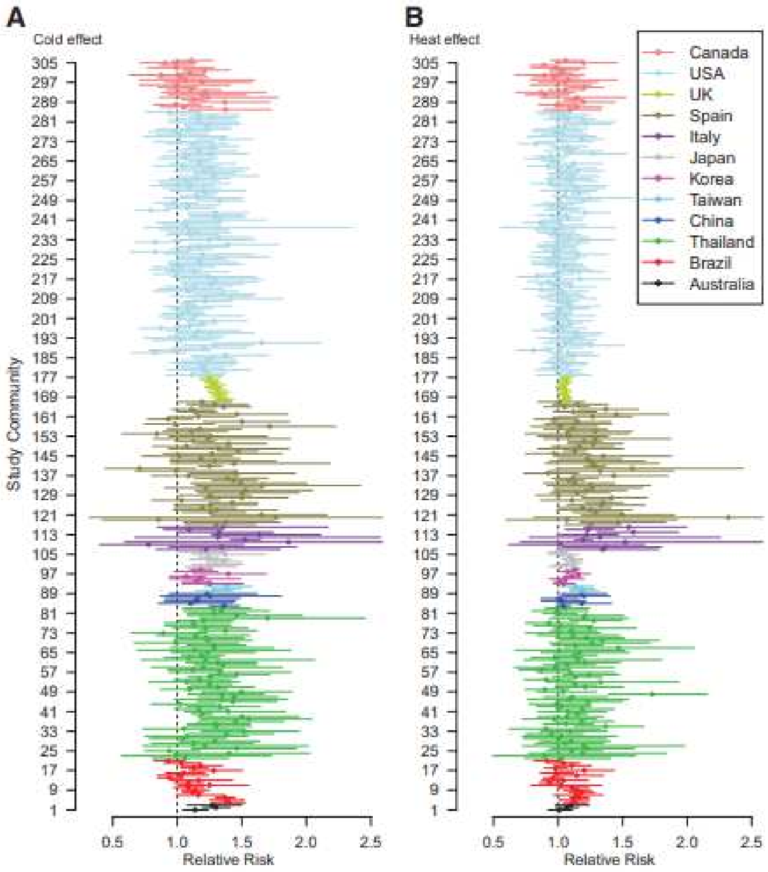
Global Variation in the Effects of Ambient Temperature on Mortality

A Systematic Evaluation

Yuming Guo,[a] Antonio Gasparrini,[b] Ben Armstrong,[c] Shanshan Li,[a] Benjawan Tawatsupa,[d] Aurelio Tobias,[e] Eric Lavigne,[f,g] Micheline de Sousa Zanotti Stagliorio Coelho,[h] Michela Leone,[i] Xiaochuan Pan,[j] Shilu Tong,[k] Linwei Tian,[l] Ho Kim,[m] Masahiro Hashizume,[n] Yasushi Honda,[o] Yue-Liang Leon Guo,[p] Chang-Fu Wu,[q] Kornwipa Punnasiri,[d] Seung-Muk Yi,[m] Paola Michelozzi,[i] Paulo Hilario Nascimento Saldiva,[h] and Gail Williams[a]

Sono disponibili numerosi studi epidemiologici che hanno mostrato l'associazione fra esposizione a temperature estreme e mortalità. I risultati di questo studio multicentrico [Guo, 2014] riportano per l'Italia un RR per la mortalità generale dovuta al caldo pari a 1.30 (IC95% 1.22-1.39).
Gli effetti risultano più persistenti e ritardati per il freddo; mentre sono stimati più rapidi e meno durevoli per il caldo.

Epidemiology • Volume 25, Number 6, November 2014 *Global Variation in Temperature-Mortality Associations*



ITALIA

FIGURE 2. The relative risks of (A) cold temperature (1st percentile versus minimum-mortality temperature) and (B) hot temperature (99th percentile versus minimum-mortality temperature) on deaths cumulated over lags of 0–21 days in each community of the 12 countries/regions. The estimates are ordered by latitude within each country. A version of this figure in color is available online. (Community names are given in eTable 1, http://links.lww.com/EDE/A819.)

Guo Y, et al. Epidemiology. 2014 Nov;25(6):781-9.

Esposizione a temperature estreme e rischio di infortuni sul lavoro. Studi analitici

Environment International 133 (2019) 105176

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Nationwide epidemiological study for estimating the effect of extreme outdoor temperature on occupational injuries in Italy

Alessandro Marinaccio[a,*], Matteo Scortichini[b], Claudio Gariazzo[a], Antonio Leva[a], Michela Bonafede[a], Francesca K. de' Donato[b], Massimo Stafoggia[b], Giovanni Viegi[c], Paola Michelozzi[b], BEEP Collaborative Group (Ancona Carla, Angelini Paola, Argentini Stefania,

- ✓ 2,277,432 occupational injuries by Inail (2006-2010);
- ✓ Temperature daily series 1X1 Km;
- ✓ Distributed lag non linear models;
- ✓ Air pollution, flu cases, temporal trend included in the analyses.

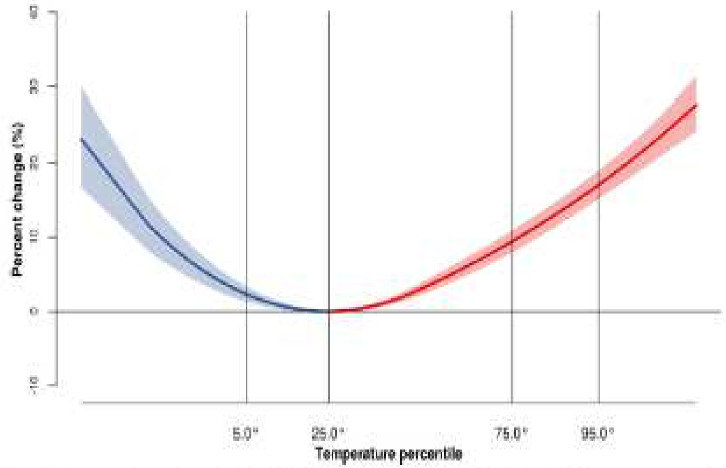


Fig. 2. Dose-response relationship. Percent change in work related injuries by temperature percentile. Blue and red areas correspond to cold and hot temperature effects. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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Marinaccio A, Environ Int. 2019 Dec;133(Pt A):105176. doi: 10.1016/j.envint.2019.105176. Epub 2019 Oct 22. PMID: 31654985.

Esposizione a temperature estreme e rischio di infortuni sul lavoro. Studi analitici

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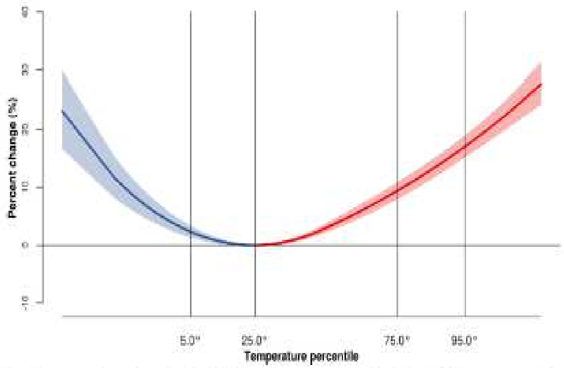


Fig. 2. Dose-response relationship. Percent change in work related injuries by temperature percentile. Blue and red areas correspond to cold and hot temperature effects. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

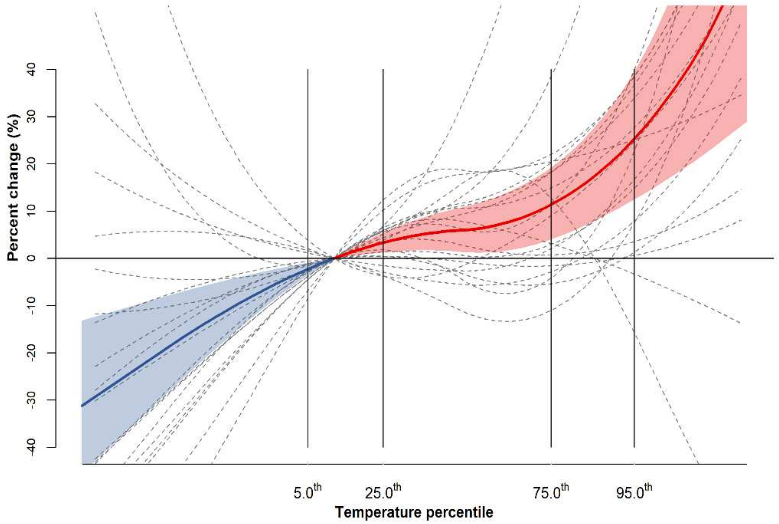
Heat (>75° percentile)

Age	Relative Risk
15-34	1.25 (1.19-1.30)
35-60	1.14 (1.10-1.80)
>60	0.91 (0.78-1.08)
Firm size	
<10 workers	1.20 (1.15-1.25)
10-49	1.19 (1.11-1.27)
50-250	1.20 (1.10-1.31)
>250	1.06 (1.00-1.18)
Sector	
Construction	1.30 (1.22-1.38)

Marinaccio A, Environ Int. 2019 Dec;133(Pt A):105176. doi: 10.1016/j.envint.2019.105176. Epub 2019 Oct 22. PMID: 31654985.

Esposizione a temperature estreme e rischio di infortuni sul lavoro. Studi analitici, settore costruzioni

Un approfondimento per il settore dell'edilizia, ha mostrato una curva esposizione-rischio di infortunio specifica e ha identificato alcuni segmenti occupazionali maggiormente coinvolti.



Caldo (>75° percentile)

Età	Relative Risk
15-34	1.25
35-60	1.24
>60	0.95
Mansione	
Muratore	1.31
Attività	
Scivolamento, caduta, …	1.53
Spostamento oggetti	
Siti	
Cave	1.25
Siti industriali	1.24

Gariazzo C, et al. Association between extreme temperature exposure and occupational injuries among construction workers in Italy: An analysis of risk factors. Environ Int. 2023 Jan;171:107677.

Esposizione a temperature estreme e rischio di infortuni sul lavoro. Studi analitici, settore agricoltura

Un approfondimento per il settore dell'agricoltura, ha mostrato un rischio di infortunio maggiormente elevato per i lavoratori giovani ed occasionali e in relazione alle ondate di calore.

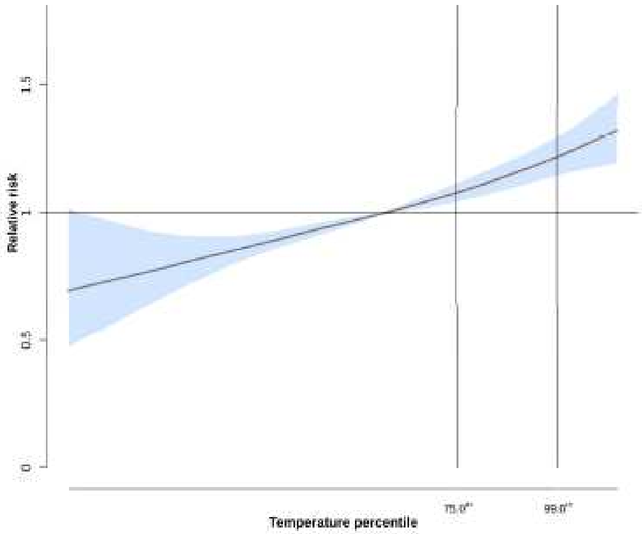


Figure 2. Meta-analytical exposure-response curve between daily mean air temperature and occupational injuries in the agricultural sector in Italy in the period 2014–2018. Estimates are expressed as Relative Risks (thick lines) and 95% confidence bands.

Età	Relative Risk
15-34	1.23
35-60	1.10
>60	1.16
Rapporto di lavoro	
Dipendenti	1.01
Autonomi	1.15
Occasionali	1.25
Heatwaves	
Ondata di calore	1.06

Di Blasi C, et al. Effects of Temperatures and Heatwaves on Occupational Injuries in the Agricultural Sector in Italy. Int J Environ Res Public Health. 2023 Feb 4;20(4):2781.

Occupational heat stress and economic burden.

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Review article

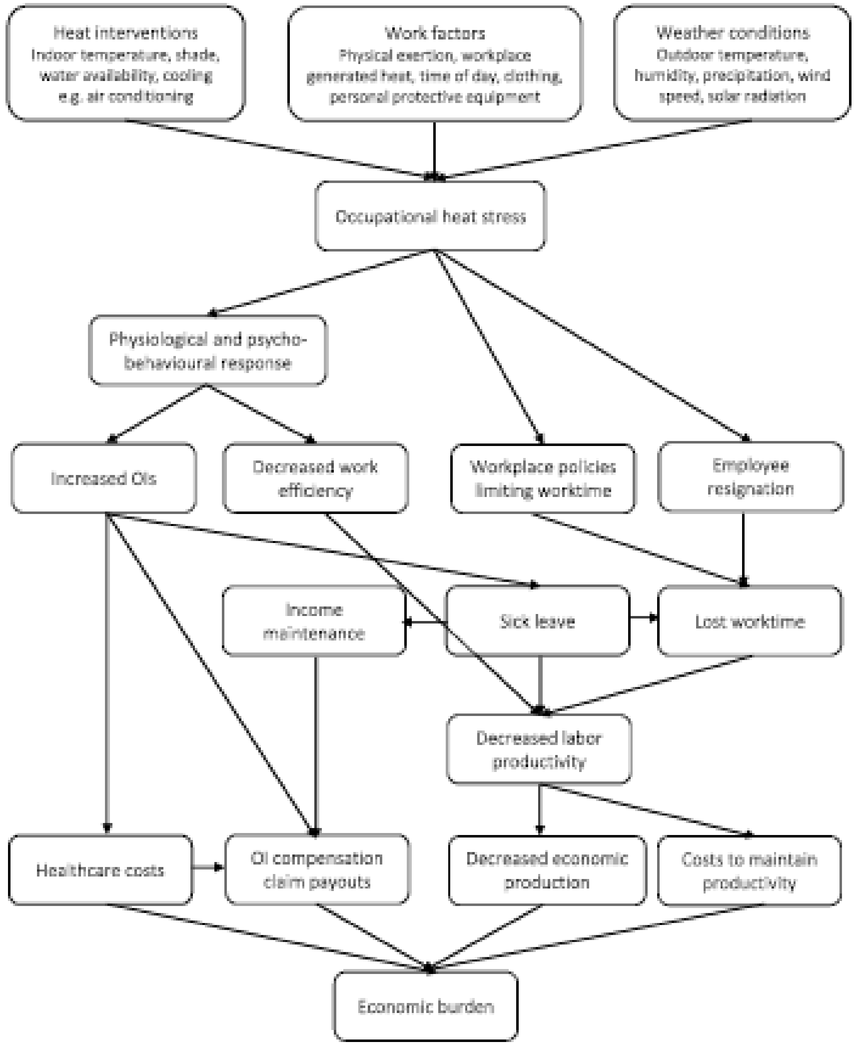
Occupational heat stress and economic burden: A review of global evidence

Matthew A. Borg[a], Jianjun Xiang[a,1], Olga Anikeeva[a], Dino Pisaniello[a], Alana Hansen[a], Kerstin Zander[b], Keith Dear[a], Malcolm R. Sim[c], Peng Bi[a,*]

The estimated global economic burden of occupational heat stress is substantial.
Predicted global costs:

- 0.5% of GDP in 2010
- > 1% of GDP in 2030
- > 4% of GDP by 2100.

Outdoor industries, medium-sized, males, workers aged 25–44 years.



Source: Borg MA, et al. Occupational heat stress and economic burden: A review of global evidence. Environ Res. 2021 Apr;195:110781.

Occupational heat stress and hours of labour lost.

The 2018 report of the *Lancet* Countdown on health and climate change: shaping the health of nations for centuries to come

"Rising temperatures are a key risk for occupational health, with temperatures regularly breaching physiological limits, making sustained work increasingly difficult or impossible.

In total, 153 billion hours of labour were lost in 2017, 80% of these losses were in the agricultural sector"

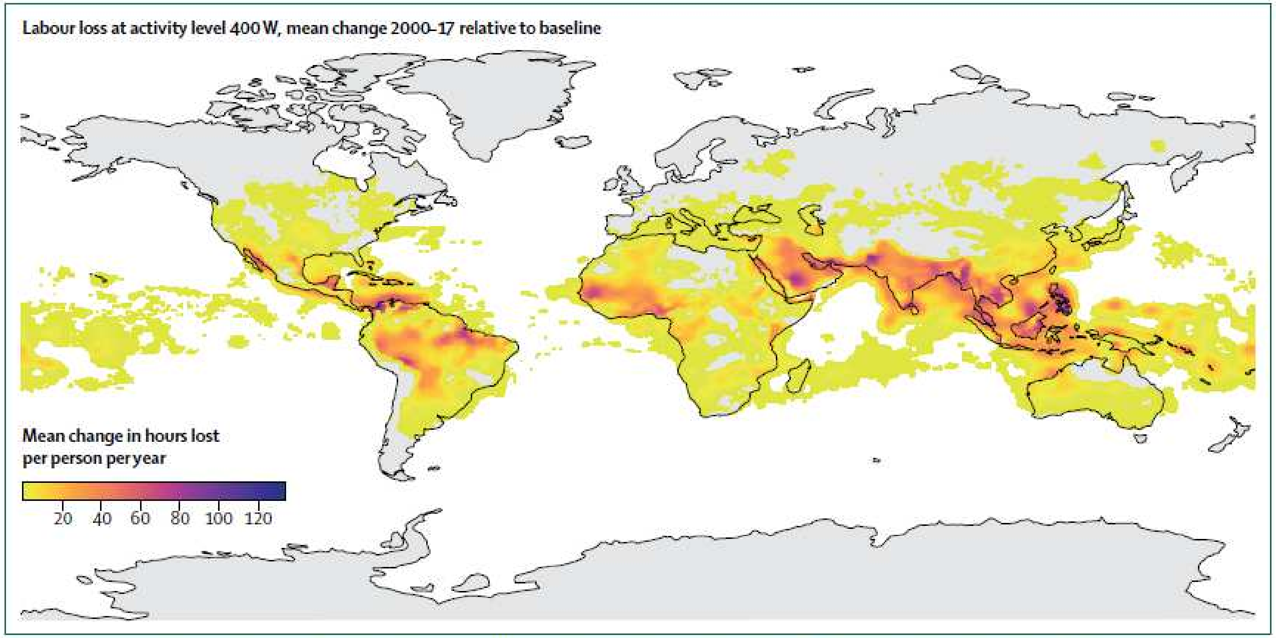


Figure 4: Mean change in total hours of labour lost at the 400 W activity level over the 2000–17 period relative to the 1986–2005 baseline

Source: Watts N, et al. The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. Lancet. 2020 Dec 8;392(10163):2479-2514.

Sorveglianza epidemiologica e stime degli effetti.

La disponibilità di analisi epidemiologiche che misurino gli effetti sulla salute e la sicurezza dei lavoratori del cambiamento climatico, è essenziale per lo sviluppo della percezione del rischio e la consapevolezza, per le politiche di prevenzione e la verifica della loro efficacia.

No data, no problem
No problem, no action.

Michael Marmot

- Improving awareness of risk
- Providing dataset for analytical studies
- Supporting risk exposure prevention policies
- Increasing insurance system effectiveness
- Checking for effectiveness of remedation and risk control

Progetto di ricerca Worklimate.
Prospettive di sviluppo e temi aperti

Analisi dei costi associati al cambiamento climatico in ambito OSH (costi/benefici degli interventi);

Sviluppo della ricerca per il tema «freddo estremo» in ambito occupazionale (settori coinvolti, misure organizzative e di mitigazione);

Analisi ed interventi in azienda (casi-studio, misure operative e verifica di efficacia);

Diffusione dei risultati, formazione, informazione (strumenti innovativi, serious game, …).