



Humidity and work-related accidents

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ABSTRACT

Analyzing almost 2.3 million work-related injuries in Italy, we estimate that higher humidity levels significantly increase the number of workplace accidents. Using dew point temperature to capture the moisture content of the atmosphere, our results confirm that a 1 °C increase in the dew point temperature raises the number of accidents by 0.7%. Allowing for non-linear effects of humidity, we uncover a U-shaped relationship highlighting that both low and high humidity levels are associated with a higher number of accidents relative to intermediate conditions.

1. Introduction

Despite a growing body of research exploiting micro-level administrative data to examine the impact of heat on work-related accidents (Heal and Park, 2016; Park et al., 2021; Ireland et al., 2023; Marinaccio et al., 2019; Filomena and Picchio, 2024; Marin and Aung Tun, 2025), the role of humidity has received comparatively little attention. Equal air temperatures can translate into markedly different physiological heat loads, as humidity critically amplifies health risks when the body's natural cooling mechanisms become less effective. By reducing the efficiency of sweating, fostering respiratory problems, increasing heat stress and thermal discomfort, particularly at night, humidity constitutes an essential, yet understudied dimension of environmental exposure (Barreca, 2012; Baughman and Arens, 1996; Goldberg et al., 2009; Caddick et al., 2018; Yan et al., 2025). Nevertheless, little is known about its economic and labor market implications.

Using dew point temperature to measure the moisture content of the atmosphere, the present paper estimates the effect of humidity on workplace injuries in Italy between 2014 and 2022.¹ To do so, we combine administrative data covering the universe of work-related accidents with meteorological variables. Thanks to the fine-grained

and daily nature of the resulting dataset, our identification strategy assumes that, conditional on a rich set of climatic controls, short-term variations in local daily dew point temperature are exogenous to workplace accidents (Ireland et al., 2023; Filomena and Picchio, 2024).

Our findings provide strong evidence that humidity increases workplace accidents. We estimate that a one-degree Celsius increase in dew point temperature increases the number of workplace accidents by about 0.7%. When dew point temperature is introduced in a non-linear form, we observe a U-shaped relationship: accidents are 6.3% higher in the lowest dew point temperature bin and 3.4% higher in the highest one, relative to the reference category.

Interestingly, dew point temperature measured during nighttime hours also shows a positive effect on workplace accidents. One possible interpretation is that high moisture levels during the night may affect sleep quality and recovery, thereby increasing fatigue during working hours. While our data do not allow us to directly observe sleep patterns or worker fatigue, this interpretation is consistent with the idea that nighttime environmental conditions may impair cognitive functioning and increase risk-taking behaviors (Escobar Carias et al., 2024). In addition, the heterogeneity analysis suggests that the effects of humidity are

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¹ Throughout the paper, we refer to humidity as the environmental condition describing atmospheric moisture content. In our empirical analysis, we use dew point temperature to measure this concept. Dew point temperature is defined as the temperature to which air must be cooled for saturation to occur, thereby providing a direct measure of atmospheric moisture. Although expressed in degrees Celsius, dew point temperature differs conceptually from standard air (dry-bulb) temperature, which measures ambient thermal conditions rather than moisture content.

not uniform across workers: young (16–29) and old (≥ 55) individuals appear more exposed, while differences by gender and nationality tend to emerge more clearly at high humidity levels.

2. Data

The analysis exploits administrative data on the universe of workplace accidents, collected by the National Institute for Insurance against Accidents at Work (INAIL). Under Italian law (Presidential Decree No. 1124/1965), employers are legally required to report all workplace accidents to INAIL for insurance purposes. Importantly, the decree requires that the exact date of each accident must be declared, irrespective of when the report is filed. This legal requirement ensures the reliability of the temporal information, allowing us to collect accidents over the period 2014–2022. The INAIL dataset also provides detailed information on the worker characteristics (such as gender and age), employer attributes (such as sector of activity), and accident details, such as the date, severity, and province (NUTS 3) in which the event occurred.

We restrict the sample to workers aged 16 and above. Moreover, following Filomena and Picchio (2024), we exclude bank holidays (April 25, May 1, June 2, November 1, and December 8) as well as the periods December 23–January 6 and August, when the number of active workers is atypically low and concentrated in sectors such as tourism. We also exclude observations with missing information on the employer's economic sector. The final dataset comprises approximately 2.3 million events. To explore heterogeneity in the effects, we construct alternative measures of workplace accidents by grouping observations according to worker characteristics (age, gender, citizenship), accident severity, and the employer's sector of activity.

We complement the data on workplace accidents with meteorological variables from ERA5, provided by Copernicus (the EU's Earth Observation Programme) which offers hourly estimates of atmospheric conditions at high spatial resolution ($0.25^\circ \times 0.25^\circ$). We construct daily measures of wind speed, precipitation amount, and air temperature across provinces by averaging hourly observations. The key element of our analysis is the use of dew point temperature as a core explanatory variable to capture the atmospheric moisture content. An important advantage of this measure is its independence from surface air temperature, which allows us to control for the latter.² Including both air temperature and dew point temperature in the analysis allows us to isolate the independent effect of moisture conditions on workplace accidents.

We measure meteorological variables at different times throughout the day. We begin by constructing daily measures of meteorological conditions by averaging all weather variables over the full 24-hour period. In addition, we complement this approach by measuring dew point temperature at different times of the day. Specifically, rather than relying on daily minimum or maximum values – as commonly done in the literature to proxy daytime or nighttime conditions – we compute the average dew-point temperature during typical working hours, from 7 a.m. to 7 p.m. (i.e., *Humidity (Daytime)*) and during nighttime hours, between 12 a.m. and 5 a.m. (i.e., *Humidity (Nighttime)*).

To conduct the analysis, we use gridded meteorological data and calculate the average value of each climatic variable within provincial boundaries. These provincial-level averages are then matched with daily workplace accident records. The resulting dataset comprises approximately 300,000 observations across 107 provinces.

Table A.1 in the Appendix reports descriptive statistics for the main variables. On average, provinces record about 7.2 workplace accidents per day, the majority of which are non-severe (5.0), while severe and fatal accidents are less frequent (2.2 and 0.01, respectively).³

² In contrast, relative humidity incorporates air temperature, potentially generating identification concerns when temperature is controlled for in the regression model.

³ (Not) Severe accidents are events that need more (less) than 30 days of absence from work but are not fatal.

3. Empirical strategy

We estimate the effect of humidity on work-related accidents using a fixed-effects Poisson regression that controls for concurrent environmental conditions. Following Filomena and Picchio (2024), Ireland et al. (2023), and Hsiang (2016), we include province–month–year and calendar-date fixed effects, exploiting plausibly exogenous daily variation in dew point temperature in each province to identify the effect of humidity on workplace accidents.

Formally, we estimate:

$$E[\text{accidents}_{it} | X] = \exp(f(\text{Humidity}_{it}; \beta) + \alpha X_{it} + \delta_t + \eta_{im}), \quad (1)$$

where i and t denote province and date, respectively. The dependent variable, accidents_{it} , is the daily number of workplace accidents,⁴ and β is the parameter of interest capturing the effect of humidity. The function $f(\text{Humidity}_{it})$ allows humidity to enter the model in a linear or non-linear form depending on the specification. In the latter case, we use a set of bin indicators that allows the effect of humidity to vary across its distribution. To do so, we divide the dew point temperature into equally sized bins of width 2°C . We follow the same procedure for air temperature, which is used as a control in Eq. (1) and included in X_{it} .⁵ The vector X_{it} also includes meteorological controls such as wind speed and precipitation amount that are modeled using polynomial terms.

Our identification strategy exploits within-province daily variation in weather. To isolate short-run fluctuations from slower-moving seasonal trends and persistent provincial climate differences, we account for province–month–year (η_{im}) and calendar-date (δ_t) fixed effects. The former absorbs local structural differences and cyclical variations in accident levels, whereas the latter captures nationwide seasonal shocks (such as “end of the month” effects). Conceptually, this approach corresponds to interpreting daily deviations from the province-specific monthly climate as quasi-random shocks. Under the assumption that such high-frequency weather variation is conditionally exogenous to workplace accidents – once fixed effects absorb seasonal patterns and common temporal shocks – our fixed-effect Poisson estimates capture the effect of atmospheric conditions on workplace accidents (Filomena and Picchio, 2024; Dillender, 2021).

4. Results

4.1. Benchmark results

Our findings highlight that dew point temperature constitutes a significant determinant of workplace accidents.⁶ Fig. 1 shows the coefficients of dew point temperature introduced in the model either in a linear (Panel a) or non-linear (Panel b) form.

We begin by discussing the dew point temperature measured over the full 24-hour period (black circles). Panel (a) shows that a one-degree Celsius increase in dew point temperature is associated with an increase of approximately 0.7% in the expected number of workplace accidents. Moreover, Panel (b) further corroborates this evidence by moving to the non-linear specification of $f(\text{Humidity}_{it})$ and allowing

⁴ We also calculate the number of daily accidents by worker (gender, age, and nationality), accident (severity), and job (sector of activity) characteristics.

⁵ In addition, we collapse values below 0°C and above 18°C for dew point temperature into tail bins. We adopt the same approach for values below 0°C and above 28°C of air temperature (Filomena and Picchio, 2024).

⁶ Coefficient estimates are presented graphically. Appendix C reports the corresponding regression coefficients underlying the figures discussed in the paper. Since the regressions are estimated using a Poisson model, coefficients are reported as incidence rate ratios (IRR). These can be interpreted as proportional changes in the expected number of workplace accidents associated with a given dew point temperature level.

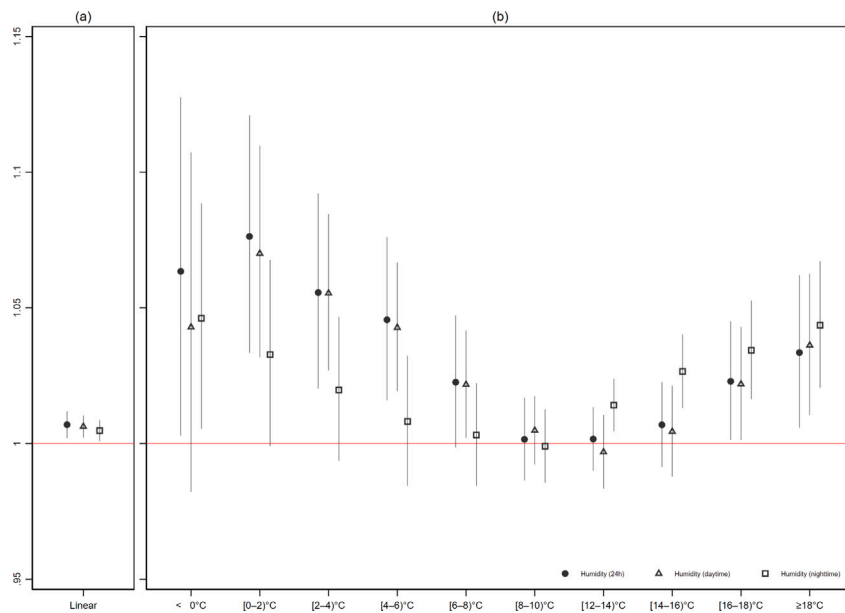


Fig. 1. Effect of humidity on daily workplace accidents.

Notes: Panel (a) reports the estimates of dew point temperature introduced in a linear form, whereas Panel (b) shows the estimates for the non-linear specification of $f(Humidity_{it})$ in Eq. (1). All specifications include year–month–province and calendar-date fixed effects. Humidity is measured using dew point temperature, averaged over 24 h (*Humidity 24 h*) (dots), between 7 a.m. and 7 p.m. (*Humidity (daytime)*) (triangles), and between 12 a.m. and 5 a.m. (*Humidity (nighttime)*) (squares). Standard errors are clustered at the provincial level.

the relationship to vary across the distribution of dew point temperature. The estimated coefficients reveal a U-shaped pattern: relative to the reference category, i.e., [10–12]°C, both low and high levels of dew point temperature are associated with higher accident levels. In particular, at the lower tail (< 0 °C) and the upper tail (> 18 °C), the number of accidents increases by about 6.3% and 3.4%, respectively, compared to the baseline category.

This pattern suggests that atmospheric moisture exerts adverse effects at both extremes of the distribution, in line with existing evidence on the influence of extreme climatic conditions on the human body (Agarwal et al., 2021; Graff Zivin and Neidell, 2014). Low dew point levels may be linked to dehydration, mucosal irritation, and increased respiratory vulnerability, whereas high humidity can intensify thermal discomfort, hinder thermoregulation, and increase physiological strain. Taken together, these findings highlight the distinctive role of atmospheric moisture in shaping occupational risk, independently of ambient air temperature.

The figure also reports alternative specifications based on daytime (triangles) and nighttime (squares) dew point temperature. Although the coefficients in Panel (a) do not reveal substantial differences in average effects across the two measures, the bin specification of $f(Humidity_{it})$ highlights meaningful heterogeneity. Nighttime humidity appears to be particularly relevant at high levels of dew point temperature, where accidents increase by approximately 3%–4% when nighttime dew point temperatures exceed 16–18 °C. Daytime dew point temperature, instead, exhibits significant effects at both tails of the distribution, with accidents rising by roughly 4%–7% and 2%–4% at low and high dew point temperature levels, respectively. This asymmetry may suggest that the timing of atmospheric moisture exposure may influence the channels through which humidity translates into workplace risk.

4.2. Effect heterogeneity

Figs. 2 and 3 explore heterogeneity in the relationship between humidity and workplace injuries across worker, employer, and accident characteristics. As in the benchmark analysis, we focus on the bin

specification of $f(Humidity_{it})$ to examine how accidents vary across the distribution of dew point temperature.

We begin by distinguishing accidents by severity. For fatal accidents, the U-shaped pattern observed in the benchmark results (Fig. 1) is less pronounced. In particular, when dew point temperature is measured over 24 h, the coefficient in the upper tail of the distribution is mildly positive and significant, whereas the lowest bin shows a negative and significant effect. In contrast, the estimates for severe and non-severe accidents broadly mirror the benchmark results, with severe accidents appearing slightly more sensitive to humidity conditions, especially at low nighttime dew point temperatures.

Next, we examine heterogeneity by gender. The U-shaped relationship between dew point temperature and accidents is more pronounced for men than for women. For women, statistically significant positive coefficients emerge only at the highest humidity levels, whereas for men positive effects also appear at low dew point temperatures. This pattern likely reflects the higher exposure of male workers to outdoor and physically demanding occupations, where environmental conditions play a larger role in shaping accidents (Yu et al., 2010; Xiang et al., 2014; Heyes and Saberian, 2019; Ireland et al., 2023; Cortes and Pan, 2018).

Turning to age heterogeneity, younger and older workers appear more sensitive to humidity-related risks than middle-aged workers. Nighttime humidity shows a somewhat different pattern. Younger workers appear to be affected primarily by higher levels of nighttime dew point temperature, while low nighttime humidity does not significantly influence their accidents. For workers aged 55 and above, instead, the effects of nighttime humidity are more evenly distributed across the range of dew point temperature bins. Although our data do not allow us to directly observe recovery processes, this pattern may reflect age-related differences in thermoregulatory capacity and nighttime physiological responses to climatic stress (Blatteis, 2012).

In Fig. 3, we further explore heterogeneity across native and foreign workers and economic sectors. Focusing on 24-hour dew point temperature, both native and foreign workers are sensitive to humidity conditions. However, the pattern differs across the two groups: native workers are affected by both low and high levels of dew point

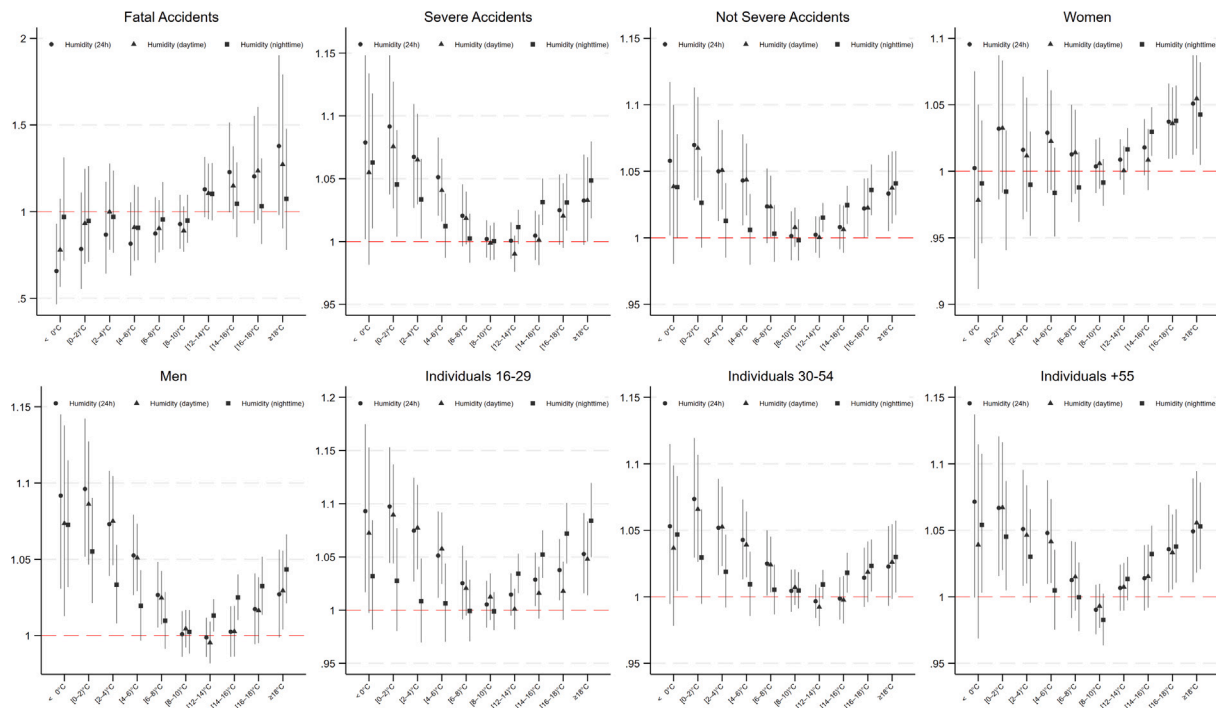


Fig. 2. Humidity and workplace accidents (by accident type, gender, and age).

Notes: All specifications include year-month-province and calendar-date fixed effects. Humidity is measured using dew point temperature, averaged over 24 h (*Humidity 24 h*) (dots), between 7 a.m. and 7 p.m. (*Humidity (daytime)*) (triangles), and between 12 a.m. and 5 a.m. (*Humidity (nighttime)*) (squares). Standard errors are clustered at the provincial level.

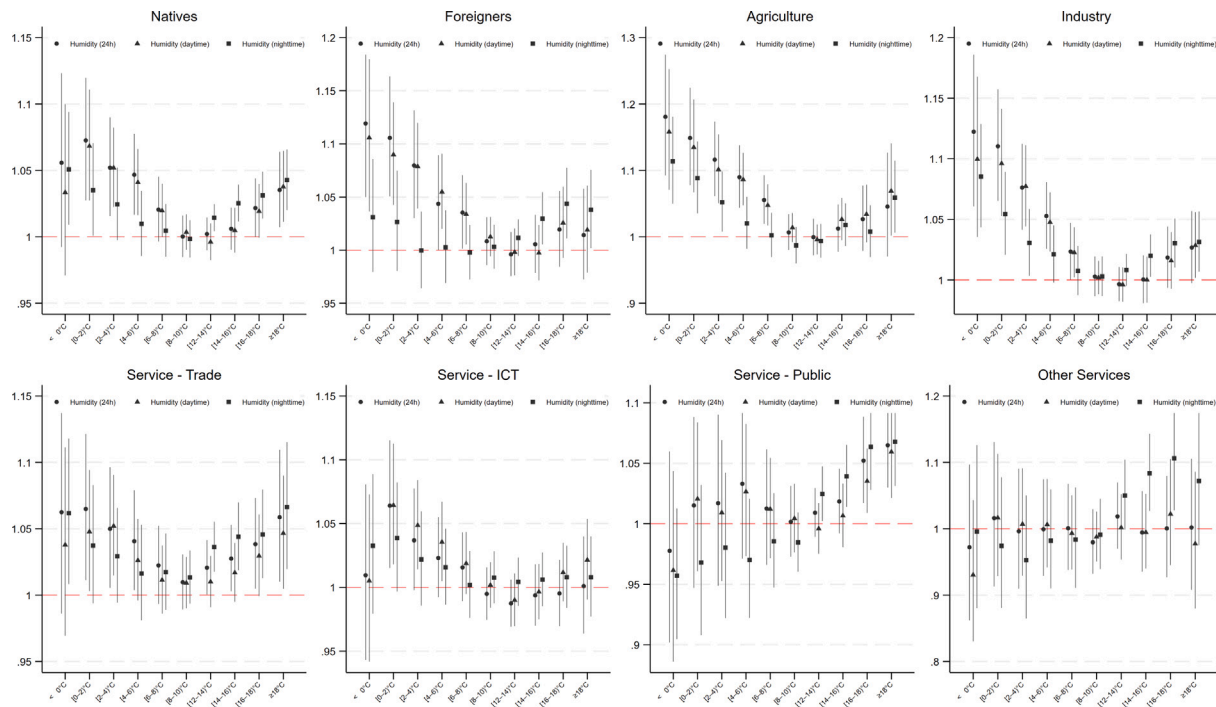


Fig. 3. Humidity and workplace accidents (by nationality and sector).

Notes: All specifications include year-month-province and calendar-date fixed effects. Humidity is measured using dew point temperature, averaged over 24 h (*Humidity 24 h*) (dots), between 7 a.m. and 7 p.m. (*Humidity (daytime)*) (triangles), and between 12 a.m. and 5 a.m. (*Humidity (nighttime)*) (squares). Standard errors are clustered at the provincial level. “Service - Trade” stands for “Trade, accommodation, rental, travel agency, and support service activities”; “Service - ICT” stands for “ICT, financial, real estate, professional, and logistics services”; “Service - Public” stands for “Public administration, education, and health services”. “Other services” stands for “Other service activities, activities of extraterritorial bodies, and activities of households as employers”.

temperature, whereas foreign workers are particularly vulnerable to low ones. By contrast, when considering nighttime humidity, both groups of workers exhibit a positive association with high dew point temperatures.

Regarding economic sectors, the models produce the largest coefficients, as expected, in agriculture and industry. In these sectors, the U-shaped pattern is particularly evident, with higher accidents emerging both at low and high levels of humidity. Moreover, service sectors are significantly affected by humidity, suggesting that even in less physically intensive environments, thermal discomfort and impaired concentration may increase workplace accidents. Indeed, sectors like travel, accommodation, etc. are characterized by the U-shaped pattern, while education and health are particularly affected by high levels of dew point temperature.

4.3. Robustness checks and placebo tests

The findings are robust to a wide set of robustness checks (Appendix B). First, we re-estimate our main specification including summer days in August (Figure B.1a). This exercise confirms the positive and significant effect of humidity on work-related accidents and the non-linear patterns observed in Fig. 1. Second, we conduct two placebo tests to assess identification validity. In the first, dew point temperatures are randomly reassigned within each province-month-year group (Figure B.1b); in the second, the randomization occurs within province-day-of-year pairs, so that, for example, Milan on January 7, 2014, may receive the humidity level of January 7, 2020 (Figure B.1c). In both cases, the estimated coefficients are statistically insignificant and close to zero. Finally, in Figure B.1d, we replicate the estimates in Fig. 1 but instead of using the average of the climatic variables at the provincial level, we use the meteorological conditions recorded in the $0.25^\circ \times 0.25^\circ$ latitude-longitude grid cell containing its capital city, using this area as a proxy for weather conditions across the entire province (Filomena and Picchio, 2024). In this setting, the core pattern is broadly confirmed especially for nighttime and daytime dew point temperature. The main difference lies in the upper-tail effect of the 24-hour indicator, which becomes weaker.

5. Conclusion

The paper provides evidence that daily humidity levels increase work-related injuries, with effects that persist after conditioning on surface air temperature. The bin specification reveals larger effects at both low and high dew point temperature levels. Average daily (24-hour) and daytime humidity (7 a.m. - 7 p.m.) are particularly relevant at these extremes, whereas nighttime humidity (12 a.m. - 5 a.m.) becomes significant only above about 12°C , when near-saturated air exacerbates heat stress and physiological strain. Moreover, we find that the relationship between humidity and workplace accidents varies across accident characteristics, worker groups, and sectors. Thus, humidity seems to be particularly detrimental for those workers who are typically more disadvantaged in the labor market.

These findings suggest that humidity constitutes an independent dimension of environmental risk and reinforce the need to incorporate it into occupational safety policies alongside heat.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Grammarly and ChatGPT in order to improve readability and language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.econlet.2026.112992>.

Data availability

Data will be made available on request.

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