Dust to Dust:
Tracing Air Pollution's Impact on Work Accidents*

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Extended abstract

One thousand workers die on an average day due to occupational injuries, according to estimates by the World Health Organization (2021). Work accidents are a severe burden on workers' health even in high income countries with service-based economies, and strict workplace safety regulations. In the EU, during 2021, at least 2.9 million workers suffered non-fatal accidents, and 3,347 died on the job (Eurostat, 2022). Besides the suffering and distress for the victims, their families, and community; work accidents result in important societal losses due to medical costs, impaired human capital, and foregone production. Some estimates for the US equal the economic burden of occupational injuries and diseases to that of cancer (Leigh, 2011). Identifying under-looked determinants of workplace risk and characterising their effects is of paramount importance. In this study we focus on the role of an important environmental vector of risk: Air pollution.

Air pollution, even at low concentration levels, can affect a myriad of our body functions. Poor air quality impacts our blood pressure, impairs our brains' neurotransmitter production, reduces lung efficiency exchanging oxygen for carbon dioxide, irritates our respiratory organs, and the list goes on. These physiological changes can manifest on individuals experiencing

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tiredness, lack of focus, irritability, or impatience. In turn, these affections can become vectors of on-the-job risk. A worker exposed to air pollution can be more inattentive to risks, conduct hazardous tasks with less precision, or suffer from delayed reaction times to danger, for example. Think of a machine operator adjusting settings on a high-speed assembly line, a momentary lapse in concentration could lead to entanglement or crush injuries from moving parts. Think of a warehouse worker stocking shelves, misjudging the weight of a box can lead to a back strain. Think of a waitress attending a crowded establishment at peak hour, missing a spilled glass can result in a slip and fall. Our hypothesis is these type of deviations can be triggered by air pollution exposure, and affect a broad spectrum of workers.

We use administrative data on the universe of work accidents reported in Spain for the years 2015 to 2019. We match municipality-by-date accident counts to information on local air pollution concentration and meteorological conditions. We exploit quasi-random variation in air quality stemming from dust precipitation events, a natural source of air pollution present in every continent on earth (Querol et al., 2019). We fit a Poisson regression with an indicator variable for whether a municipality is affected by dust precipitation. We include municipality-by-year fixed effects to account for differences across municipalities on baseline determinants of work accidents, as well as for heterogeneous time trends. We also include day-of-the-week and month indicator variables in our specification. These indicators capture work accident patterns common to all municipalities, and account for seasonal factors affecting the incidence of both dust precipitation and work accidents. Furthermore, we control for weather conditions that may affect workplace safety and correlate with dust precipitation with a rich set of dummy variables. Hence, we exploit within municipality and year variation on dust pollution, net of seasonal components and accounting for weather conditions.

A day of dust pollution increases work accidents by 1.2 percent on the affected municipality, according to our main estimate. We show this effect is driven by dust precipitation events occurring on already polluted municipality-by-date cells. This finding is consistent with non-linear effects of air pollutant concentrations on work accidents.

As a next step, we provide a detailed characterization of the effects of air pollution across workers. To do this, we repeat our main analysis taking as an outcome variable the accident count of particular groups of workers. First, we classify occupations according to an accident-risk score in three groups: Low risk, moderate risks, and high risk. We find large and significant effects of dust precipitation on accidents for workers on both moderate and high-risk occupations, which employ about 40 percent of the workers in Spain. The point estimate for low risk occupations is meaningful in magnitude, 0.8 percent, but statistically insignificant. Second, we study the impact of dust pollution along the income distribution.

We find dust precipitation results in work accidents for workers of very different income levels, with large and significant effects found in the 2nd and 4th quintiles of the wage distribution. Finally, we conduct a similar heterogeneity of effects analysis across accidents of increasing degrees of severity. We find sizeable and significant impacts for accidents across the severity spectrum. Accidents that result in a sick leave of one week or less are the most sensitive, increasing by 2 percent on a dust precipitation day. Accidents resulting in a sick leave of more than one month also increase by 1 percent as a response to dust precipitation. We find positive point estimates for the most severe accidents (i.e. those resulting in permanent disabilities or deaths). However, these are infrequent events, making the estimates less precise, and statistically insignificant.

Concluding, this study underscores the imperative need for policy interventions that address air pollution as a significant determinant of workplace safety. Our findings reveal that even natural sources of air pollution, such as dust precipitation events, considerably elevate the risk of work accidents across various sectors, occupations, and income levels. This indicates a broader spectrum of workers are vulnerable to environmental pollutants than previously recognized. Policy makers, therefore, must broaden the scope of occupational health and safety regulations to include environmental health measures, especially in light of climate change's role in intensifying dust precipitation events globally. By integrating air quality improvements into workplace safety protocols, not only can we potentially reduce the economic burden of work accidents on society, but more importantly, we can safeguard the health and well-being of workers. The evidence presented advocates for a multidisciplinary approach to workplace safety, where environmental, occupational, and public health policies converge to mitigate the risks posed by air pollution, thus ensuring a safer and more productive working environment for all.

Related literature: Previous studies have documented a meaningful relation between environmental factors and workplace safety. The most closely related papers to ours are observational studies estimating the impact of short-term variations in air pollution on work accidents (Vega-Calderón et al., 2021; Chambers, 2021; Lavy et al., 2022; Depalo and Palma, 2023). While these studies have focus mainly on anthropogenic pollution sources, we focus on a natural source of air pollution pervasive around the globe: dust precipitation. Furthermore, we leverage highly detailed information about the work accidents to estimate heterogeneous effects of air pollution shocks across dimensions such as the nature of the accident, the characteristics of the worker, and the consequences of the event. Hence, we complement previous studies by offering the most comprehensive characterization to date of the heterogeneous effects of an air pollution shock.

Another strand of the economics literature studies the impact of temperatures and climate change on workplace safety (Dillender et al., 2018; Park et al., 2021). Our paper is relevant to this domain, as dust precipitation is a climatic phenomenon highly correlated with high temperatures and dry conditions. We uncover dust precipitation as another channel through which changing climate patterns can impact workplace safety. This has relevant implications beyond Spain, since dust precipitation is a source of pollution present in all continents (Querol et al., 2019).

We extend the economic literature documenting the costs of dust outbreaks. Economists have primarily estimated their burden on health outcomes in Africa (Adhvaryu et al., 2019; Heft-Neal et al., 2019), America Jones (2020), and Asia (Jia and Ku, 2019). Looking beyond health consequences, Jones (2022, 2023) has found dust storms in the US induce higher violent crime rates, and worse subjective well-being. We augment mentioned findings by focusing on the effects of dust episodes in regions far from the source. In dust-receiving areas such as Europe, the impact of dust outbreaks on the physical environment is less extreme and salient. However, these territories expand tremendously the area of influence of dust outbreaks. To illustrate with an example, The Caribbean is an important dust-receptor of the Sahara Desert; so much so NASA has a Saharan dust warning system in place for the region. Hence considering dust pollution impacts beyond source regions becomes crucial to fully account for its impacts.

Turning our focus to the workplace implications of dust pollution, the study most closely aligned with our research is that of Holub et al. (2020). This research documents a negative impact of dust precipitation-induced air pollution shocks on labor supply, primarily through an increase in sick-leave take-up. This aspect of dust pollution's impact opens up a critical avenue for further investigation. Our findings complement these in at least two ways. First, we focus on an outcome likely originated due to the sub-clinical effects of air pollution (i.e.,

fatigue, lack of focus, impatience, etc.), where sickness serves more likely as a channel. Meanwhile, the outcome in Holub et al. (2020), sick-leave take-up, tracks a more direct pathway from pollution exposure to sickness. Second, work accidents differ significantly from common sick leaves in terms of the events that trigger them, the degree of responsibility employers have in protecting against them, their medical consequences, and the type of workers more vulnerable to them, among other factors. Hence, to properly assess the economic burden of dust pollution and protect against it, understanding its separate impact on work accidents is essential. We fill this gap by providing a novel estimate of the costs of dust pollution in terms of work accidents provoked, and the resulting days of work lost and foregone productivity.

Finally, our paper adds to the literature documenting the effects of air pollution on "non-health" outcomes (see Aguilar-Gomez et al., 2022, for a recent review), which focuses on the consequences of the sub-clinical physiological effects of air pollution. In particular, our study speaks to the literatures connecting poor air quality to negative impacts in physical and cognitive performance (Sager, 2019; Ebenstein et al., 2016); risk behaviors (Bondy et al., 2020); and productivity (Chang et al., 2016; Dechezleprêtre et al., 2019). Again, we extend this evidence by documenting the negative impacts of a different air pollution source: dust precipitation.

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