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RESEARCH FOR THE WORLD

The hidden costs of air pollution

Published 7 September 2021

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With the majority of the world's population living in areas of high air pollution, the need for clean air has never been more urgent. And poor air damages more than just our health, argues **Sefi Roth**, whose research has revealed ties to increases in crime and decreases in academic performance.

Ambient air pollution is high on the agenda. **According to the World Health Organisation (WHO)**, 91 per cent of the world's population live in places where air pollution levels exceed their guideline limits.

"We have a public health emergency in many countries from pollution. It's dramatic, one of the biggest problems we are facing globally, with horrible costs to society." Maria Neira, Director of Public Health, Environment and Social Detriments, WHO

Air pollution: a public health emergency

The link between mortality and radically elevated concentrations of air pollution is well established. Studies of London's Great Smog of 1952 for example, which is classed as an "extreme episode", estimate that over 10,000 people died as a result, despite it lasting just a few days.

Dr Sefi Roth, Assistant Professor of Environmental Economics in LSE's Department of Geography and Environment told a virtual audience at a recent LSE Research Showcase event, "We don't tend to see these extreme events much in developed countries, and actually if you look at trends across time we see a significant decline in air pollution levels, which is great. Most of this reduction comes from good policies."

However, researchers have, over the last 30 years, begun to study the effects of more common air pollution levels, the kind of levels we experience every day, and have proven that you don't have to be in an extreme pollution situation to be negatively affected. One of the most famous studies, **The Harvard Six Cities** in 1993, found that citizens in cleaner cities in the US had on average a two to three year longer life expectancy.

Dr Roth continues, "Importantly, these so called 'dirtier' cities in this study were within the US Environmental Protection Agency guideline levels at the time, so

nothing extreme. And, for context, two to three years of added life expectancy is approximately the equivalent of finding a cure for cancer in the USA, so this is really significant.

"There is a misconception when you talk about air pollution that it is mainly something you worry about in developing countries, places like China or India, or some of more of the traditional hotspots like Santiago in Chile, but this is not the case – it's a big issue not just in these places but also here in Europe, here in the UK and here in London more specifically."

> A link between harmful ambient air pollution and these other factors (ie, cognitive abilities) would suggest that we have underestimated the true costs of air pollution.

Air pollution contributes to over 400,000 (or one in eight) annual deaths in Europe, **according to the EU's environment agency**. A **Bloomberg article in March** argued that air pollution would kill far more people than COVID-19 ever will, with more than 10 million deaths a year (compared with an estimated 2.6 million people for COVID).

And it's not just mortality we have to worry about. Air pollution also causes non-fatal health problems, from aggravated asthma to chronic bronchitis, and even milder impacts like headaches, dizziness, and fatigue. "We need to think about all the impacts and the costs they come with, particularly when thinking about policy," Dr Roth explains.

Dr Roth's research has been exploring the effects of air pollution on other aspects of human life, including education (and cognitive performance more broadly) and crime. He says: "Why is this important? A link between harmful ambient air pollution and these other factors would suggest that we have underestimated the true costs of air pollution, that we have underestimated the benefits of pollution reduction by only focussing on the direct health outcomes."

Ambient air pollution is negatively impacting cognitive performance

> Those exposed to higher levels of pollution were less likely to go to university, on average they completed fewer years of education, and importantly they earned less money.

To test the possible effects of ambient air pollution on cognitive performance, Dr Roth and his team looked at a dataset of test results from the Bagrut in Israel, a standardised high-school exit exam similar to A levels in the UK, over the period of 2000 to 2002 for over 400,000 subject examinations. To ensure what they were

looking at was a causal link, not just a correlation, rather than compare students from different schools (who may have different social circumstances, for example, and other factors affecting their scores), they compared individual students' performances over the course of the exam period, as they were subjected to different levels of pollution each day.

"We found a very large impact on test scores - students exposed to higher levels of pollution perform much worse. To give you some context - the size of the effect on cognitive performance, the improvement if you have better air quality, is similar to that found in other studies of reducing class sizes from 31 to 25. This is significant."

The team also looked at the data on these students eight to 10 years later in their lives, to see whether short term exposure during a very important exam had an impact on longer term labour market outcomes. They found that those exposed to higher levels of pollution were less likely to go to university, completed fewer years of education, and importantly they also earned less money.

"We're talking about something that happened 10 years ago and it still affects your earning. You were exposed to a high level of pollution on one day, on one important day, when you take an important exam and it might mean that you reduce your lifetime earnings by two to three per cent."

Ambient air pollution is linked to an increase in crime

> Wherever the wind goes we saw both an increase in pollution and an increase in crime.

Another hidden cost Dr Roth has investigated is the effect of air pollution on crime, using extensive data on daily crime levels in London between 2004 and 2005, covering more than 1.8 million offences and their location, and comparing this to data on daily air pollution levels.

To ensure a causal link this time, again they compared the same area to itself over time as it experienced different levels of pollution, rather than comparing one neighbourhood to another, where there might be many confounding factors affecting both crime and pollution levels.

Another, more innovative way of proving that the link was more than just coincidence, Dr Roth's team used wind direction as a source of random variation.

"A randomised control trial, the gold standard of empirical research (which is used for things like new drugs or vaccines), is not possible (or at least not ethical) in this area – you can't subject people intentionally to harmful levels of air pollution, so we had to find another way."

Therefore, the team looked at daily variation of wind direction to statistically mimic a randomised control trial. Sometimes the wind blows in one direction, sometimes another – taking pollution with it to different parts of London at random. "Wherever the wind goes we saw both an increase in pollution and an increase in crime."

The underlying reason for this link has not been conclusively established. One suggestion is that air pollution affects certain hormones in the human body, including cortisol, that changes particularly your perception of risk, but there is more work to be done.

The implications for policy makers

So it is well established that exposure to air pollution affects human health, but Dr Roth's research has shown it also affects other aspects of human life like education and crime. Other researchers have evidenced links to labour productivity and more general well-being.

"If you think about the cost of air pollution, it is more than what we originally thought, more than just the direct health costs," argues Dr Roth. "Think about how much money we put into education, and crime reduction – maybe reducing air pollution is a cost-effective way both of reducing crime and improving educational outcomes.

"Air pollution reduction is possible – we are already living in a much better situation than we were 20 years ago, policies can have an impact. We don't need to have zero pollution, we can't achieve zero pollution, but we need to reduce it to an optimal level. These hidden costs should make policymakers rethink what is the true optimal level of pollution." ■

Sefi Roth was speaking to Louise Jones, Senior Communications Manager at LSE, as part of the ***LSE Research Showcase*** online series in July 2021.

The LSE IQ podcast episode ***How can we tackle air pollution?*** is also available on LSE Player.