The health effects of long-term exposure to air pollution: New evidence from linked administrative data in Northern Ireland

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Introduction

This policy brief explores the detrimental health effects of long-term exposure to outdoor air pollution in Northern Ireland. It draws on existing research together with our own research using linked administrative data from a variety of sources.

Air pollution affects people throughout their lifetimes. Our research spans *in utero* exposures and infant outcomes, such as birth weight, through to adult exposures and outcomes, such as premature mortality and a wide range of long-term health conditions. This research and policy brief mainly considers fine particulate matter pollution ($PM_{2.5}$), although we have also estimated health effects from exposure to nitrogen dioxide (NO_2) and other pollutants.

This body of research uses statistical modelling to isolate the impacts of differences in pollution exposures from other differences between those exposed to higher or lower levels of pollution – for example, in terms of demography, socio-economic characteristics, and other geographical and time-related contextual factors.

This policy brief provides a brief outline of the current context, the key messages from research, the key remaining gaps in our understanding, and the implications for clean air policy in Northern Ireland.

Context

As we go about our daily lives, we are exposed to both outdoor and indoor air pollution, and both are harmful to our health. We currently know more about the harmful health effects of outdoor air pollution than indoor air pollution.[1] The World Health Organisation (WHO) estimates that outdoor $PM_{2.5}$ air pollution – a particularly harmful pollutant that can pass from our lungs into our bloodstream and then to all parts of our bodies – causes 4.2 million premature deaths worldwide per year.[2] Equivalent estimates for England suggest 28,000-36,000 premature deaths per year.[1] Existing estimates for Northern Ireland have suggested that outdoor air pollution leads to 300-800 premature deaths per year.[3, 4]

There is also extensive global evidence that exposure to outdoor air pollution is associated with a wide range of specific illnesses.[5] These include cardiovascular and respiratory diseases,[6, 7, 8] age-related cognitive decline and dementia,[9, 10] diabetes,[11, 12] mental ill health,[13] and how people perceive their general health.[14, 15] Of course, association doesn't necessarily imply causation, and those living in higher pollution areas tend to have other characteristics that make them more likely to experience poor health outcomes. However, the US Environmental Protection Agency conducted a detailed assessment of the global research literature and biological mechanisms through which air pollution can impact on different health outcomes. They concluded that $PM_{2.5}$ outdoor air

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pollution causally affects mortality, cardiovascular health, and *likely* causally affects respiratory health and cancer.[16] A similar assessment for NO_2 concluded that respiratory health is causally impacted by exposure, with suggestive but not definitive evidence of causal effects on mortality, cardiovascular health, and cancer.[17]

Despite this extensive global evidence base, however, prior to our own research programme there had been very little research specific to Northern Ireland. The most notable exceptions – a handful of estimates of the mortality burden of air pollution in Northern Ireland – extrapolated research evidence from elsewhere to provide estimated effects for Northern Ireland, rather than estimating pollution effects directly using Northern Ireland population data.[3, 4, 18] Although such estimates provide crucial evidence, they are limited in several important respects, including the extent to which they can account for the particular health and socio-economic contexts of the Northern Ireland population. There has also been a dearth of evidence specifically for Northern Ireland on the morbidity effects of air pollution.

Our research, which includes completed and ongoing projects, aims to address these evidence gaps in Northern Ireland. Studying a wide range of health outcomes and life stages, together with in-depth statistical analysis, it separates the effects of pollution exposures from other (measured and unmeasured) differences between people living in higher and lower pollution neighbourhoods – making this body of research particularly valuable. This in-depth research into the health effects of pollution exposure in Northern Ireland was only possible due to linked administrative data. Using administrative data in this way can help researchers, policymakers, third sector organisations, and the public better understand how pollution exposure affects our health. It helps to provide a crucial evidence base to inform policy discourse and policy interventions to reduce the harms of air pollution in Northern Ireland and beyond.

Previous policy responses and strategies

In contrast to the other UK nations, Northern Ireland still has no clean air strategy in place. This is despite work on a clean air strategy having been ongoing for several years. For example, the Department of Agriculture, Environment and Rural Affairs (DAERA) conducted a consultation on a draft strategy in 2020/2021,[19] publishing a summary of responses in 2022.[20] These responses suggested strong support for:

- introducing legally binding targets for particulate matter based on WHO guidelines
- expanding Northern Ireland's air pollution monitoring network and the set of pollutants covered by each monitor
- introducing additional restrictions on the use and sale of smoky fuels such as wood and coal
- expanding urban Air Quality Management Areas.

There was more mixed support for introducing Low Emissions Zones (LEZs) covering all aspects of air quality in urban areas and introducing vehicle charges for entry to the most polluted urban areas in Northern Ireland. Dissatisfaction was expressed with the current process in place to address Northern Ireland's ammonia emissions, which are disproportionately high compared to other parts of the UK.

Meanwhile, policy has progressed far more rapidly elsewhere. For example, in October 2022, the Republic of Ireland introduced a nationwide ban on the sale of smoky coal, turf and wet wood.[21] England has also recently

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introduced restrictions on the sale of wet wood for domestic burning and the most polluting types of wood stoves.[22] Such restrictions recognise that not all fuels for domestic heating, which is a major source of $PM_{2.5}$ pollution, are equally polluting. WHO pollution targets are already written into Clean Air Strategies in other parts of the UK, such as Scotland.[22] At a local level, we have seen the introduction or expansion of LEZs and Ultra LEZs in many cities in other parts of the UK, including London.[1]

Messages from research

Our research uses several unique linkages of administrative data for Northern Ireland. These include linking Department for Environment, Food and Rural Affairs air pollution data with anonymised versions of the Northern Ireland Longitudinal Study (NILS), the Enhanced Prescribing Database (EPD), and the Northern Ireland Maternity Services database (NIMATS) - all in secure research settings under strict privacy standards. These data linkages enable us to model the pollution exposures and health outcomes for the Northern Ireland population at the individual level. We have also linked European Environment Agency pollution data with aggregate mortality data at the Local Government District level. This allows us to estimate the premature mortality impacts of exposure to $PM_{2.5}$ air pollution across Northern Ireland.

Our research shows that, although outdoor air pollution has been slowly falling in Northern Ireland over the last few decades, most of us in Northern Ireland are still exposed to outdoor air pollution well in excess of the WHO's guideline levels, above which air pollution poses substantial health risks. Further, although air pollution tends to be worse in larger towns and cities, this problem is not confined to major urban areas. For more detail on air pollution levels across Northern Ireland, including an interactive postcode-level search function that shows pollution levels in local neighbourhoods across the whole of Northern Ireland, see the Northern Ireland Air Pollution Dashboard.

The table overleaf summarises our research findings to date on how the health effects of exposure to outdoor fine particulate ($PM_{2.5}$) air pollution in Northern Ireland could be reduced by cutting pollution.

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Health Outcome	Associated with air pollution?	Evidence that association is likely to be causal?	Estimated magnitude of effect[1]
Premature Mortality	✓	✓	approx. 400 fewer premature deaths p.a.
Poor self-rated general health	✓	✓	≥17% reduction
Chronic illness (incl. cardiovascular disease, diabetes, cancer)	✓	✓	≥18% reduction
Breathing difficulties	✓	✓	≥11% reduction
Mobility difficulties	✓	✓	≥10% reduction
Deafness / hearing loss	✓	✓	≥20% reduction
Long-term pain	✓	?	.
Blindness / sight loss	✓	✗	.
Mental ill health	✓	✗	.
Memory loss	✓	✗	.
Infant health-related outcomes at birth (incl. birthweight)	✓	✗	.

Note: [1] With the exception of the estimated effect on premature mortality (which estimates the total number of premature deaths per year that would be saved by achieving the 2021 WHO guideline level for outdoor $PM_{2.5}$ air pollution in all parts of Northern Ireland), estimated magnitudes give the minimum estimated % reduction in prevalence for each health outcome from a 5μg/m^3 reduction in average $PM_{2.5}$ exposure.

More detail on these research findings, and estimates for the health effects of other pollutants such as NO_2, can be found in the following papers and reports:

- Goodman, P., Jahanshahi, B., McVicar, D., Rowland, N. (2023). Air Pollution and Mortality on the Island of Ireland. Irish Heart Foundation. https://irishheart.ie/wp-content/uploads/2023/03/Air-Pollution-and-Mortality-on-the-Island-of-Ireland-Report.pdf.
- Rowland, N., McVicar, D., Vlachos, S., Jahanshahi, B., McGovern, M., O'Reilly, D. (2024). Long-term Exposure to Ambient PM2.5 and Population Health: Evidence from Longitudinally-linked Census Data. QBS Working Paper 2024/01, Queen's Business School, Queen's University Belfast. https://www.econstor.eu/handle/10419/281175.
- Jahanshahi, B., Johnston, B., McVicar, D., McGovern, ME., O'Reilly, D., Rowland, N. and Vlachos, S. (2022). Prenatal Exposure to PM2.5 and Infant Birth Outcomes: Evidence from a Population-Wide Database. Discussion Paper No. 15464, IZA, Bonn. https://www.iza.org/publications/dp/15464/prenatal-exposure-to-pm25-and-infant-birth-outcomes-evidence-from-a-population-wide-database.

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In addition to the research summarised above, we have ongoing projects examining the relationships between exposure to air pollution and Parkinson's Disease, childhood asthma, premature mortality, and dementia in Northern Ireland.

Recommendations for policy and practice

In his 2022 Chief Medical Officer's Annual Report (for England), Professor Chris Whitty set out numerous policy recommendations to reduce air pollution, covering areas such as transport, planning, industry, agriculture and domestic heating. These include measures such as speeding up the electrification of light vehicles and public transport, measures to reduce air pollution near schools and healthcare settings, encouraging active travel, improving the precision of the application of slurry to soil and the covering of slurry-stores, and training healthcare staff in the health effects of air pollution and how they can be minimised.[1] Many of these recommendations, and many of the other steps already taken elsewhere in the UK and Ireland, could be adopted here in Northern Ireland if given sufficient political will.

But without an overarching, dynamic and ambitious Clean Air Strategy for Northern Ireland, progress on tackling air pollution and its harmful effects is likely to be slow. We therefore limit our recommendations for policy and practice to three broad points:

- A **Clean Air Strategy for Northern Ireland** should be introduced as a matter of urgency.
- This Clean Air Strategy should commit to introducing **legally binding targets for particulate matter and other damaging pollutants based on 2021 WHO guidelines**. These should be introduced over a timeframe to be determined by a detailed evaluation undertaken within the first 1-2 years of the Strategy period.
- **Improved monitoring and modelling of air pollution in Northern Ireland** is needed, including of the constituents (speciation) of particulate matter, along with further research on its consequences for both health and the regional economy.

We recognise that Northern Ireland faces some particular challenges in this policy area, including the widespread use of (more polluting) oil-fired heating and disproportionate reliance on solid fuel heating compared to other parts of the UK.[21] But these challenges can also be treated as opportunities, and as our research clearly demonstrates, this is too important a matter to keep kicking down the road.

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