

Are there inequalities in exposure to PM_{2.5} air pollution across Ireland?^{1, 2}

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INTRODUCTION

Adverse health effects of exposure to air pollution are widely acknowledged within the Irish policy context and recognised in initiatives such as *Healthy Ireland* and *Sláintecare*. However, research on whether some groups in the population are more exposed to air pollution is relatively scarce. While existing European studies suggest that socio-economically advantaged households tend to be located in areas characterised by better air quality, this relationship has not been examined at a granular level within Ireland. We aimed to fill this knowledge gap by exploring the link between air pollution, as captured by ambient particulate matter (PM_{2.5}) concentrations, and demographic, social, and economic characteristics of small areas across Ireland.

DATA AND METHODS

The analysis first linked maps of average annual PM_{2.5} concentrations in Ireland (for 2011 and 2016) to the 2016 Irish Census small areas. From this, we created a map of average PM_{2.5} across small areas in Ireland in 2011 and 2016 and investigated changes in air pollution over time. This map was then linked to two sources of socioeconomic data: (i) the Pobal Haase and Pratschke (HP) Deprivation Index, which is an index of deprivation created using demographic and socioeconomic information from the 2016 Census, and (ii) individual- and household-level socioeconomic indicators from the 2016 Census, known as Small Area Population Statistics (SAPS).

Using both descriptive analyses and statistical models, we examined whether individuals living in areas characterised by greater levels of deprivation experienced greater concentrations of PM_{2.5}. The analysis was replicated for the different SAPS indicators, including educational attainment, social class, housing

¹ This Bulletin summarises the findings from: Hoy, A., Mohan, G., and Nolan, A. (2024) An investigation of inequalities in exposure to PM_{2.5} air pollution across small areas in Ireland. *International Journal of Health Geographics*. Available at: <https://ij-healthgeographics.biomedcentral.com/articles/10.1186/s12942-024-00377-4>

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status, ethnic composition, and age profiles of areas. The investigations were also stratified by urban and rural classifications of small areas.

RESULTS

The mapping of PM_{2.5} concentrations across small areas in Ireland showed an overall decline in the levels of PM_{2.5} between 2011 and 2016, with heavier concentrations in urban areas. Despite the observed decline, almost all small areas in Ireland in 2016 exceeded the World Health Organisation (WHO)'s PM_{2.5} annual guideline of $5\mu\text{g}/\text{m}^3$.

Overall, the statistical modelling did not find substantial evidence of demographic or socio-economic inequalities in PM_{2.5} concentrations across small areas. However, where socioeconomic indicators were examined separately for urban and rural areas, some small differentials in PM_{2.5} concentrations were observed. In general, those living in more disadvantaged small areas in rural Ireland had higher levels of PM_{2.5} air pollution than those living in more advantaged small areas in rural Ireland.

CONCLUSIONS

Broadly the work indicated that inequalities in PM_{2.5} concentrations were not observed across small areas characterised by different demographic and socio-economic profiles in Ireland. However, the study also revealed that exposure to PM_{2.5} varied depending on the urban and rural categorisation of small areas, and the choice of socioeconomic indicator. As such, this work highlights that the association between PM_{2.5} concentrations and socioeconomic characteristics is complex, and interpretation of findings depends on the choice of socioeconomic indicators and spatial scale of the analysis.

These results provide policymakers with a greater understanding of links between PM_{2.5} concentrations, a measure of air quality in Ireland, and the composition of small spatial geographies. The Clean Air Strategy published by the Irish Government in 2023 contains a commitment to achieve the WHO's guideline limits for PM_{2.5} by 2040, with interim targets at various points over the next two decades. Future work, using the 2022 Census and updated PM_{2.5} data and nitrogen dioxide (NO₂) data, will aid in our understanding of spatial inequalities in air pollution exposure across Ireland and highlight groups in need of policy attention. Installing more monitoring stations at key points could improve the quality and spatial dimensions of the data collection, facilitating a stronger assessment of the inequality of exposures to air pollution in Ireland.