



One Health
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Economic and Cognitive Impacts of Chronic PM Exposure in Małopolskie, Poland (2013–2018)

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Introduction

Context and Relevance

- The Małopolskie region, particularly Kraków, exhibits one of the highest annual PM_{2.5} and PM₁₀ concentrations in the European Union, often exceeding WHO limits by 5–8 times.
- While air pollution is traditionally studied for its respiratory and cardiovascular consequences, economic and cognitive impacts remain largely unnoticed and unquantified.

Scientific Gap

Most assessments focus on hospital costs, mortality, or disability, overlooking the broader societal and productivity-related consequences, especially in regions with knowledge-based economies.

Objective of the Study

To estimate the cognitive and productivity-related economic losses attributable to chronic PM exposure in Małopolskie (2013–2018), and compare them to traditional direct healthcare costs.



Materials and methods

Study Design

- Ecological regional study analyzing environmental, health, demographic, and economic datasets.

Geographic focus: **Kraków and surrounding Małopolskie region.**

Time frame: **2013–2018**

- **Data Sources**

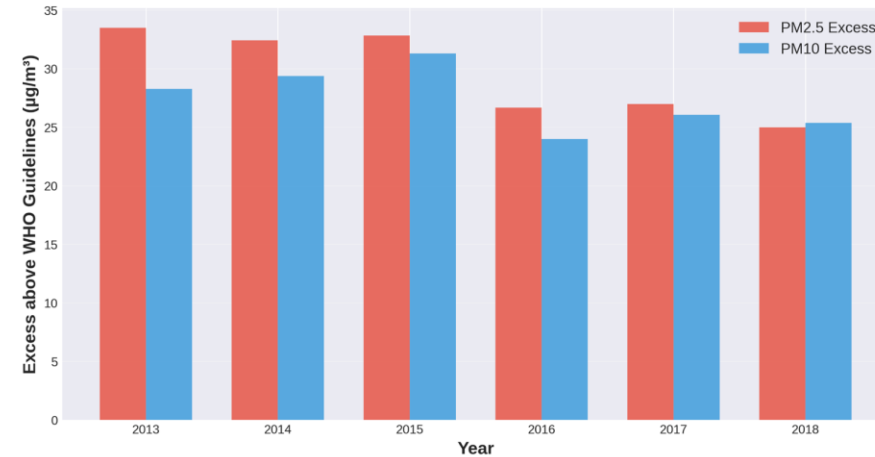
Type	Source
PM2.5 / PM10	EEA
Respiratory mortality & hospitalizations (ICD-10 J00–J99)	Eurostat
Population & aging dynamics	Statistics Poland
Wages, productivity (GDP/hour)	OECD
Cognitive decline coefficients	Zhang et al. 2018; Cullen et al. 2022



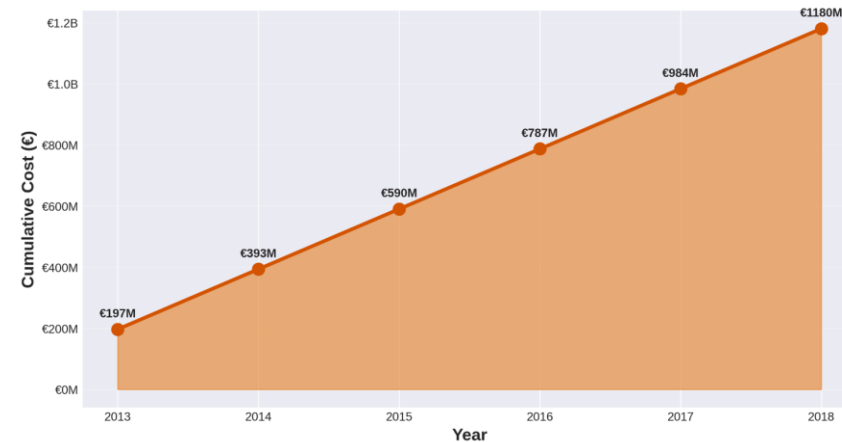
Results and discussions

Key Findings	
Air Pollution Levels	PM2.5: 6–8× above WHO limit - PM10: ~3× above WHO limit • Slight decline in PM2.5, PM10 remained stable
Health Impact (2013–2018)	Respiratory mortality: +23% • Hospital admissions: +26% • Aging population increased vulnerability
Cognitive Impact	Decline in verbal ability: −8.77% - Decline in mathematical reasoning: −5.20% - Long-term exposure linked to cognitive degradation
Economic Impact	Productivity loss due to cognitive decline: €1.18 billion - Direct healthcare costs: €38.3 million • 30× higher than medical costs

PM Concentrations Exceeding WHO Air Quality Guidelines
Małopolskie Region, 2013-2018



Cumulative Economic Impact from Productivity Loss
Due to Cognitive Impairment, 2013-2018





Conclusions and recommendations

1. Conclusions

- Chronic PM exposure in Małopolskie remains substantially above WHO thresholds, despite moderate reductions in PM_{2.5} over time.
- The economic consequences extend far beyond healthcare, with cognitive decline representing a major hidden cost.
- Traditional methods (hospital cases, mortality) substantially underestimate true socioeconomic impacts.
- The majority of losses emerge from reduced productivity in knowledge-oriented sectors, rather than medical treatment.

2. Policy Implications

- Economic models should incorporate cognitive decline and productivity metrics, not only healthcare indicators.
- Air quality policies must be interdisciplinary, integrating economic, environmental, and neurological perspectives.
 - Investments in clean energy and urban planning could yield substantial long-term economic benefits.



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Thank you for your attention!

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