June 2024

VALESOR
Valuation of environmental stressors

Policy Brief

Effects of socio-economic status on vulnerability and susceptibility to air pollution

Key messages

- People with lower socio-economic status (SES) are in general exposed to higher concentrations of air pollution, and thus they have increased "vulnerability", but this also differ between cities and countries.
- In this systematic review and meta-analysis of studies evaluating the effect of $PM_{2.5}$ on mortality stratified by education or individual income (as markers of SES), the effect estimates were not statistically different between the various subgroups.
- The evidence is limited with high heterogeneity, thus further studies are required to draw firm conclusions.

Air pollution poses significant health concerns, ranging from respiratory issues to cardiovascular diseases and even neurological effects. Some such as fine particles ($PM_{2.5}$), can penetrate deep into the lungs, causing inflammation and aggravating existing conditions like asthma and bronchitis. It can also induce/exacerbate cardio-vascular diseases and increases overall mortality.

According to the WHO, ambient air pollution is estimated to have caused around 4.2 million premature deaths worldwide in 2019.

Air pollution & Socioeconomic Disparities

While environmental risk factors affect everyone, the magnitude of the impact is not equally distributed. The terms **vulnerability** and **susceptibility** refer to different aspects of how individuals or populations are affected. Vulnerability refers to a broader concept that encompasses the overall risk someone faces, and it is related to either a higher exposure, a higher vulnerability to exposure due to limited access to healthcare or poorer health, or both. The reasons may be social, economic, and environmental. **Susceptibility** is more specifically related to biological sensitivity or predisposition to harm from environmental factors. It refers to the degree to which a person's health is affected by pollutants based on their physiological characteristics. For example, exposure to air pollution in young children as they are more sensitive to air pollution than adults because they breathe in more air per unit of body weight and, consequently, more air pollution. Certain communities, often those with lower socio-economic status (SES), face disproportionate exposure to harmful pollutants. Socioeconomic status (SES) can potentially influence the state of health, and poor health is associated with lower education, less work capacity, and thereby lower earned income.

There are two main factors contributing to the SES-health relationship: 1) the ability to access health-promoting resources and treatments and 2) differences in health habits and lifestyle factors. Due to this SES difference in air pollution exposure & health, epidemiological studies of air pollution effect adjust for these factors. Additionally, studies have assessed if air pollution associated health outcomes differ by SES.

Addressing these socioeconomic disparities in air pollution exposure and subsequent health outcomes is crucial for advancing environmental justice and promoting equity (Figure 1).

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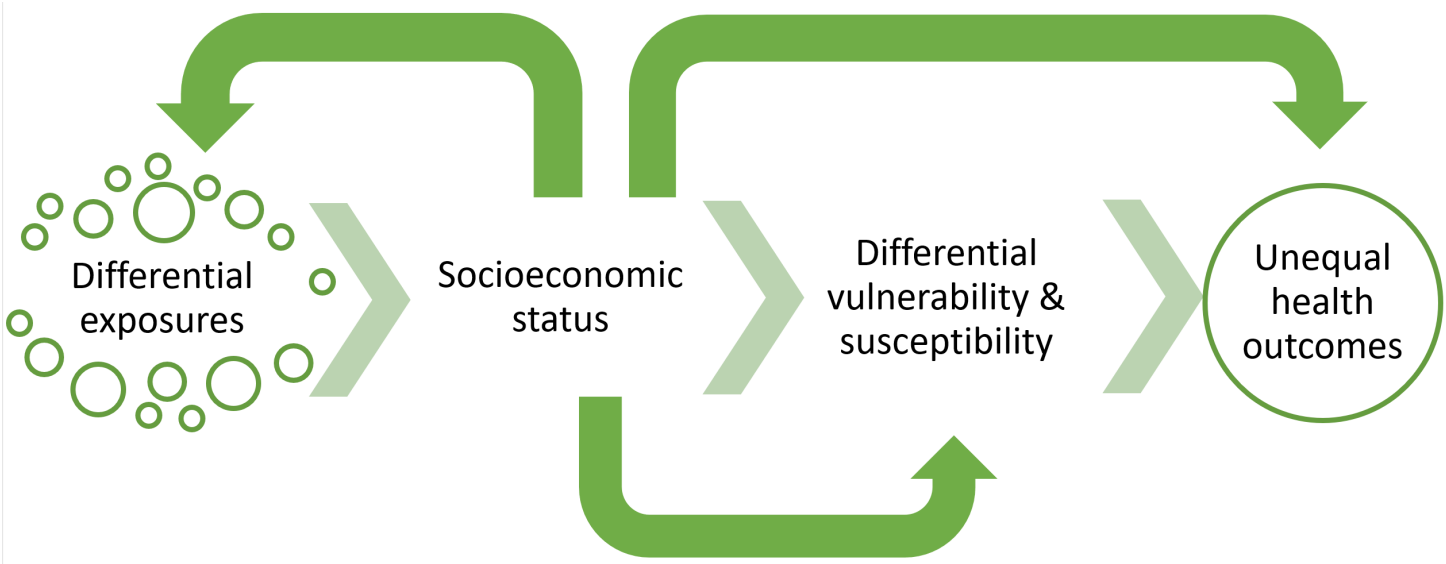

Figure 1. The potential pathways by which SES can increase both vulnerability and susceptibility to air pollutants.

In the VALESOR project a systematic literature review and a meta-analysis were performed. The literature review was based on a compilation of previous studies addressing the impact of SES as level of education and income, on health effects related to air pollution. In the meta-analysis, the impact of SES on long-term mortality was analysed. A secondary aim was to assess the remaining confounding effect of individual lifestyle factors (such as smoking, alcohol intake, physical activity, diet, and body mass index) after adjustment for SES. The literature search was conducted using to the complete Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist (Figure 2).

The initial literature search yielded 1,097 articles, out of which 217 remained after screening the titles and abstracts. After screening the full texts, we further excluded 201 records and selected a total of 16 studies for a meta-analysis of SES factors. Seven studies were conducted in Europe, six in North America, and three in Asia. Eight studies provided risk estimates stratified by individual-level education, and three studies by individual-level income. The remaining confounding effect due to individual-level lifestyle factors, after adjustment for individual-level SES factors, was assessed in eight studies.

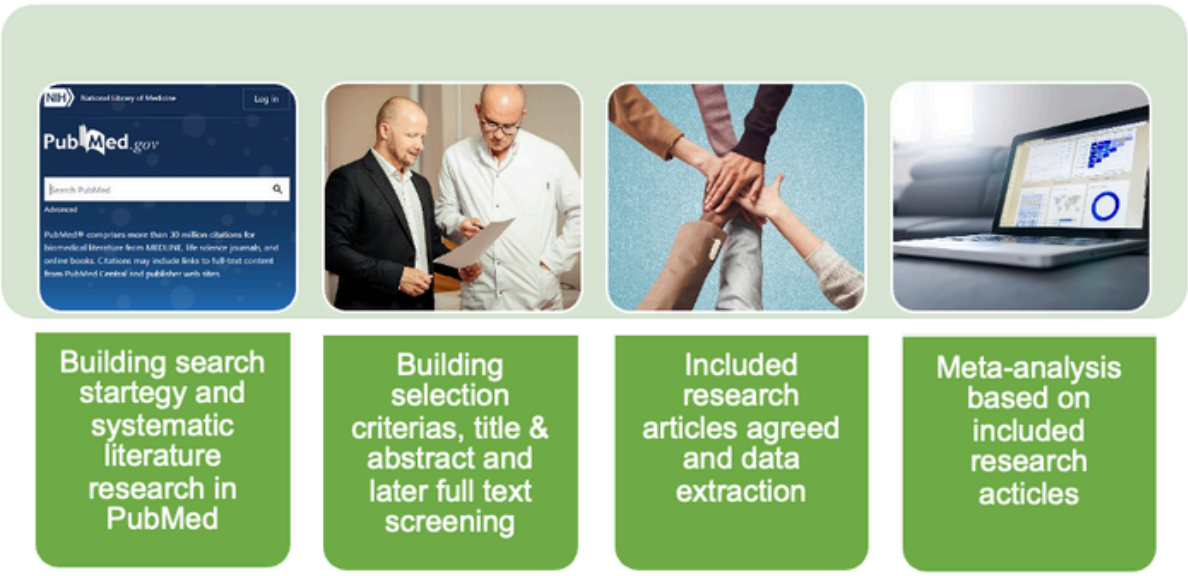

Figure 2. Systematic review and meta-analysis flow.

Research Findings

Although the point estimates of the meta-coefficients in the subgroups of primary, secondary, and tertiary education showed increased risk, the meta-analysis results did not indicate any statistically significant difference in the size of the relative risk (RR) for all-cause mortality in relation to $PM_{2.5}$ by individual-level education (Figure 3).

The risk estimates were not statistically significantly different when comparing income in quintiles 2, 3, 4, and 5 with quintile 1. The RRs adjusted for both individual lifestyle factors (such as smoking, alcohol intake, physical activity, diet, and body mass index) and SES were not significantly different when compared to those adjusted for SES factors only. Even though studies generally observed higher air pollution concentrations among lower SES groups, this differed between cities and countries.

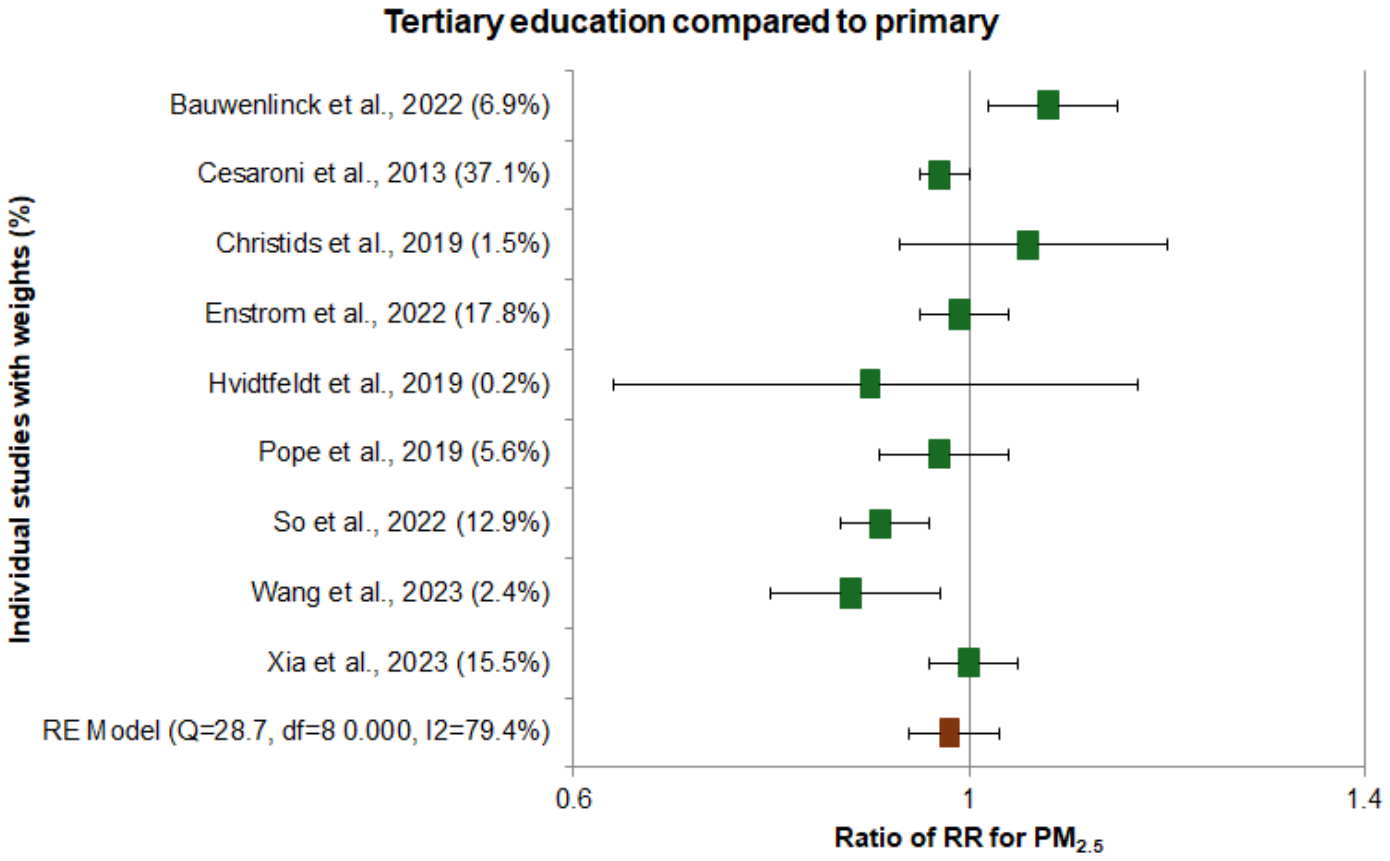

Figure 3. Modification of the association between fine particles ($PM_{2.5}$) and total mortality by level of education.The forest plot indicates the ratio of the RR for mortality in relation to $PM_{2.5}$ in groups with higher versus primary education.

Results in the HIA context

An important question in the context of air pollution exposure, SES, and their impact on health is to what extent differential exposure and differential susceptibility to air pollution among lower SES groups are relevant for conducting health impact assessments (HIAs). HIA itself is a decision-making tool that studies how factors, policies, decisions etc may impact health and well-being. As RRs for all-cause mortality associated with $PM_{2.5}$ did not depend on education or individual income, the same RRs can be applied in health impact assessment despite the SES status. The variations in health impacts among different SES groups will be driven by differences in exposure and by differences in mortality rates.

Policy Implications

Healthcare Access and Social Support: Improve healthcare and social services in underserved areas to combat air pollution's health effects. Expand coverage, enhance preventative care, and tackle social factors like poverty and housing instability. Invest in community health programs for better outcomes.

Equity-Centric Policy Formulation: Prioritize fairness and community involvement in air quality policy. Create regulations that address vulnerable populations' needs and distribute environmental benefits fairly.

Community-Centered Approaches: Support communities advocating for clean air by partnering with government, organizations, and academia. Offer education, monitoring tools, and engagement platforms for active participation in decision-making.

Targeted Pollution Reduction Strategies: Implement tailored measures to reduce pollution in heavily affected areas. Regulate emissions from industries and traffic, while investing in clean energy and sustainable transportation. Prioritize environmental justice for effective interventions.

References:

Baker EH. 2014. Socioeconomic status, definition. The Wiley Blackwell encyclopedia of health, illness, behavior, and society, 2210-2214.
Bauwelinck M, et al. 2022. Variability in the association between long-term exposure to ambient air pollution and mortality by exposure assessment method and covariate adjustment: a census-based country-wide cohort study. Sci Total Environ 804, 150091.
Bell ML, et al. 2005. Challenges and recommendations for the study of socioeconomic factors and air pollution health effects. Environ Sci Policy 8(5), 525-533.
Cesaroni G, et al. 2013. Long-term exposure to urban air pollution and mortality in a cohort of more than a million adults in Rome. Environ Health Perspect 121(3), 324-31.
Christidis T, et al. 2019. Low concentrations of fine particle air pollution and mortality in the Canadian Community Health Survey cohort. J Environ Health 18, 1-16.
Enstrom JE, 2005. Fine particulate air pollution and total mortality among elderly Californians, 1973–2002. Inhal Toxicol 17, 803-816.
Hvidtfeldt UA. 2019. Long-term residential exposure to $PM_{2.5}$, PM_{10}, black carbon, NO_2, and ozone and mortality in a Danish cohort. Environ Int 123, 265-272.
Pope III, CA, et al. 2019. Mortality risk and fine particulate air pollution in a large, representative cohort of US adults. Environ Health Perspect 127, 077007.
So R, et al. 2022. Long-term exposure to air pollution and mortality in a Danish nationwide administrative cohort study: Beyond mortality from cardiopulmonary disease and lung cancer. Environ Int 164, 107241.
Wang Y, et al. 2023. Estimating causal links of long-term exposure to particulate matters with all-cause mortality in South China. Environ Int 171, 107726.
WHO. 2022. Ambient (outdoor) air pollution. World Health Organisation, Geneva.
Xia Y, et al. 2023. Associations of outdoor fine particulate air pollution and cardiovascular disease: Results from the Prospective Urban and Rural Epidemiology Study in China (PURE-China). Environ Int 174, 107829.

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VALESOR project aims to make major contributions to the scientific- and policy communities, with efforts to accommodate economic values of environmental stressors more homogenously in policy making and planning. The environmental stressors of concern for VALESOR are chemical stressors including chemicals and pollutants transmitted via air, water, and soil vectors. VALESOR project is supported by the EU's Horizon Europe Programme (Grant agreement ID: 101095430). Pictures used in the current policy brief is from www.pixabay.com