The impact of socioeconomic factors on long-term mortality associated with exposure to PM$_{2.5}$: A systematic literature review and meta-analysis

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Introduction

Exposure to fine particles (PM$_{2.5}$) has a wide range of health effects; however, the effect modification of socioeconomic factors (e.g. education, income and socioeconomic status) is not entirely clear (Figure 1). Current study aimed to systematically review the existing studies and calculate separate meta-coefficients on long-term mortality and PM$_{2.5}$ in groups with different socioeconomic status (SES).
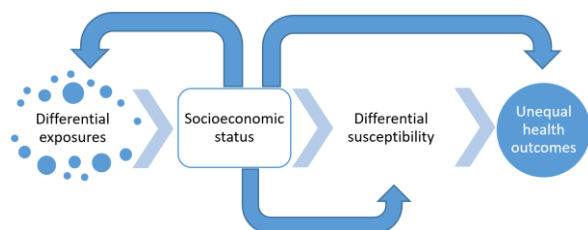

Figure 1. The potential pathways by which SES can increase both vulnerability and susceptibility to air pollutants.

Material and methods

In VALESOR project a 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 analyzed. A secondary aim was to assess the remaining confounding effect of individual lifestyle factors (such as smoking, alcohol intake, physical activity, eating behaviors, and body mass index) after adjustment for SES. The literature search was conducted according to the complete Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist.

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.

Results

Although the point estimates of the meta-coefficients in the subgroups of primary, secondary, and tertiary education had 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 PM2.5 by individual-level education (Figure 2). Neither the risk estimates differ significantly when comparing income in quintiles 2, 3, 4, and 5 with quintile 1. Also the RRs adjusted for both individual lifestyle factors (such as smoking, alcohol intake, physical activity, eating behaviors, and body mass index) and SES were not statistically significant when compared to the RRs adjusted for SES factors only. With generally higher air pollution concentrations among lower SES groups, it can be assumed that a specific increase in PM$_{2.5}$ concentration does not have as great an effect on susceptibility to long-term mortality as a higher increase in concentration.

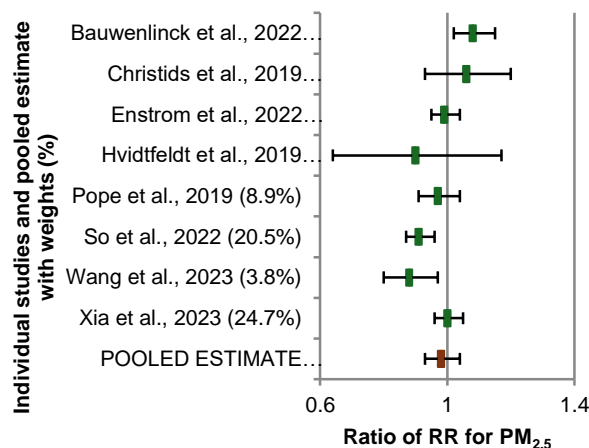### Higher education compared to primary

Figure 2. Modification of the association between fine particles (PM$_{2.5}$) and total mortality by level of education.

Conclusions

The RRs for all-cause mortality associated with PM$_{2.5}$ did not depend on education or individual income. More research on the effects of SES based on different air pollutants, total air pollution concentrations, SES factors, and geographical areas is needed to gain a better understanding of how these factors are connected.