

Tromboembolismo venoso: aspetti clinici e diagnostici

LONG-TERM EXPOSURE TO AIR POLLUTION AND RISK OF INCIDENT VENOUS THROMBOEMBOLISM: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Background and Aims. Long-term exposure to ambient air pollution was linked to arterial cardiovascular disease. Evidence regarding its association with venous thromboembolism (VTE) remains less clearly established. A systematic review with meta-analysis is needed to summarize the knowledge and identify key research gaps.

Methods. Embase, MEDLINE and Pubmed were searched for studies published in English up to June 30th, 2025 without time restrictions. Inclusion criteria were observational studies on adults (18+ years old) evaluating the association between exposure to outdoor air pollutants and VTE incidence, including deep vein thrombosis (DVT), pulmonary embolism (PE), and VTE at unusual sites. Risk of bias was assessed using the ROBINS-E checklist. Hazard ratios (HRs) with 95% confidence intervals (CIs), expressed for 10 µg/m3 increase in pollutants, were pooled using a random effects approach. Exposures included PM2.5, PM10, nitrogen dioxide (NO2), and ozone (O3). Heterogeneity was evaluated using the I2 statistic. The study protocol was registered (PROSPERO-ID:CRD420251071570).

Results. We identified 11 studies (7 cohorts, 2 case-control and 2 case-cross over; 4 USA, 4 Europe and 3 Asia) comprising 4,718,128 individuals published between 2008 and 2024. The meta-analytical HRs for PM2.5 (9 studies: 6 VTE, 2 DVT, 1 PE) and PM10 (10 studies; 7 VTE, 1 DVT, 2 PE) were 1.13 (95%CI:1.04-1.22) and 1.17 (1.02-1.34), respectively; estimates were consistent across studies reporting composite VTE vs. DVT or PE. For both pollutants, heterogeneity was substantial (I2>0.90). Leave-one-out validation attenuated the risk increase for PM2.5 to 1.07 (1.03-1.12) after excluding one study on a high-risk MEDICARE population. Kendall's tau tests for funnel plot asymmetry revealed no publication bias (p-values>0.60). NO2 and O3 contributed with 3 studies each, all with HRs larger than one and most statistically significant.

Conclusions. Long-term exposure to air pollutants, in particular to particulate matter, is an emerging risk factor for the incidence of VTE