

***European Society of Cardiology position paper on air pollution  
and  
new scientific evidences***



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In the early 21<sup>st</sup> century, air pollution has emerged as a potentially modifiable risk factor for the development of cardiovascular disease (CVD)

Multiple observational studies have demonstrated an association between fine particulate air pollution (primarily from the use of fossil fuels in automobiles, power plants, and for heating purpose) and cardiovascular and cardiopulmonary mortality as well as an increased risk for development of acute coronary syndromes.

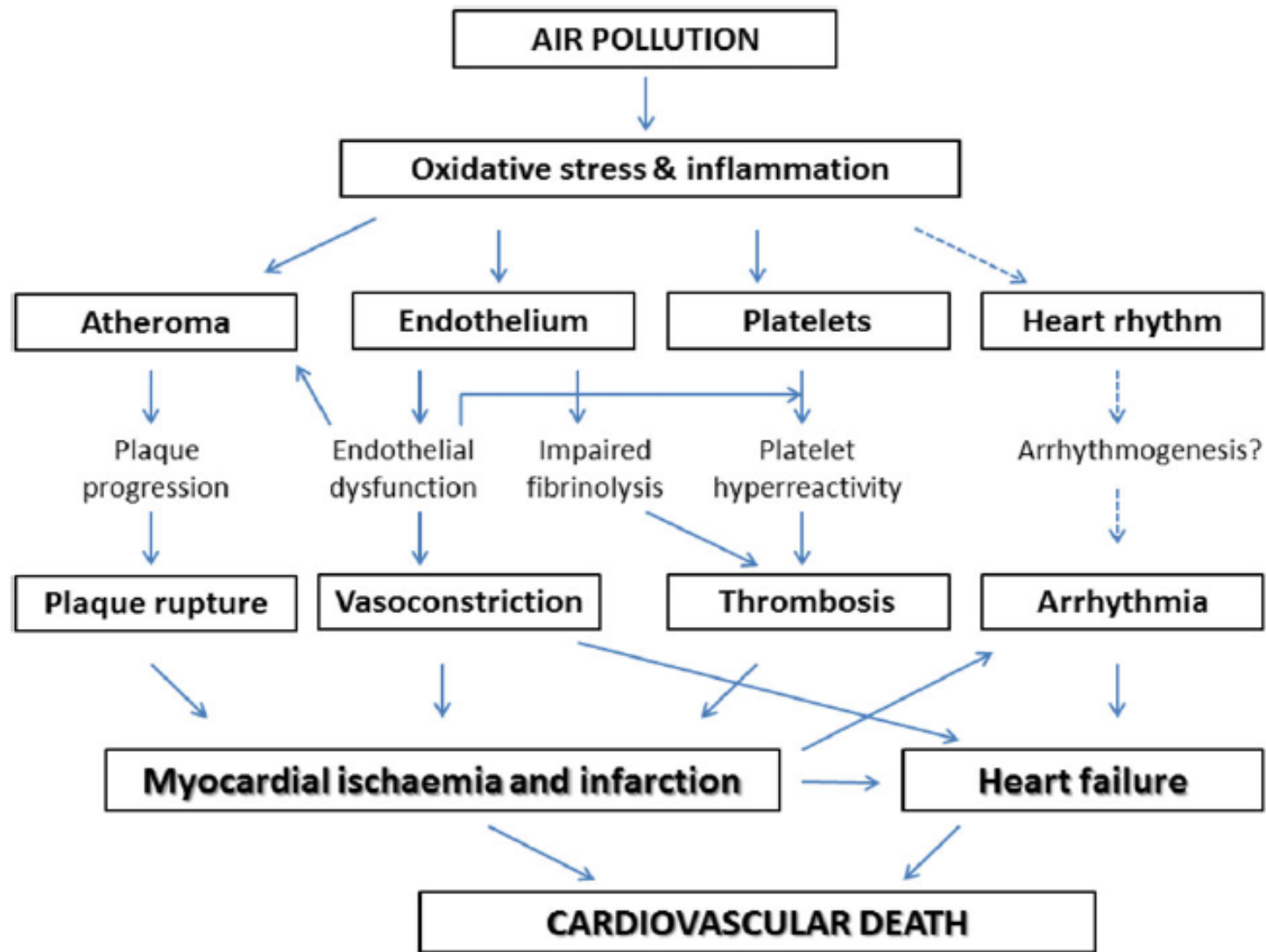


## Expert position paper on air pollution and cardiovascular disease

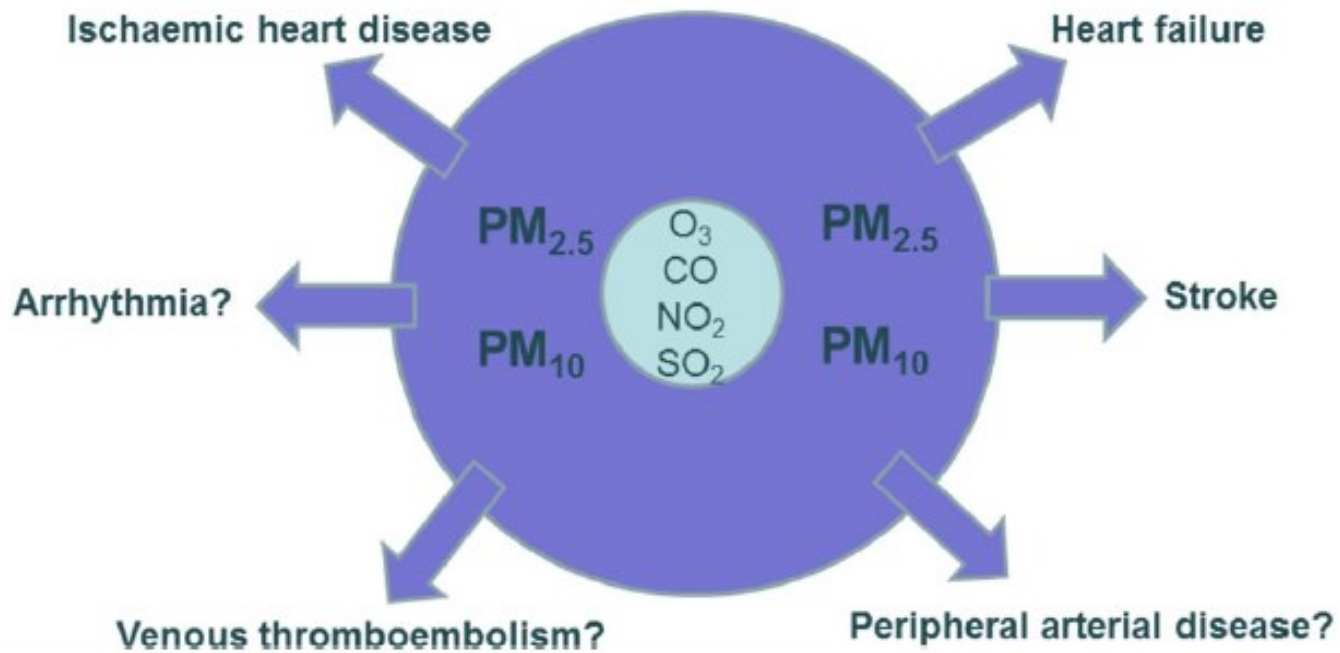
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- Associations with cardiovascular morbidity and mortality is seen not only in long term exposition to air pollution but also with short-term (e.g. day-to-day fluctuations) pollutant exposures of residents in large urban areas worldwide, including United States of America and Europe.
- Among multiple pathways linking air pollution to cardiovascular morbidity and mortality, the most relevant are the induction of oxidative stress, systemic inflammation, endothelial dysfunction, atherothrombosis, and arrhythmogenesis.



**Figure 2** Possible mechanistic effects of air pollution on cardiovascular morbidity and mortality. Based on Mills *et al.*<sup>9</sup> and Forastiere and Agabiti.<sup>27</sup>



**Figure 3** Established and unsettled clinical outcomes related to air pollution (gaseous and particulate).

# Coronary artery disease

## Long term link between exposure to air pollution and risk of incidental fatal or non fatal coronary artery disease

- Women's Health Initiative Study (an analysis of more than 65.000 post menopausal women) showed a 21% (95% CI 4-42%) increased incidence of combined fatal and non-fatal coronary heart disease per increase of  $10 \mu\text{g}/\text{m}^3$  in  $\text{PM}_{2.5}$

# Interaction with cardiovascular traditional risk factors

A bidirectional relationship exists between air pollution and cardiovascular risk factors

- Air pollution may acutely exacerbate and chronically instigate the development of several traditional risk factors
- An elevation in blood pressure occurs within hours-to-day
- Long term exposures to PM<sub>2.5</sub> and traffic-related pollutants may promote the development of chronic hypertension
- Long term PM<sub>2.5</sub> reduction of 10 µg/m<sup>3</sup> is associated with an increased life expectancy of 0.61 years.





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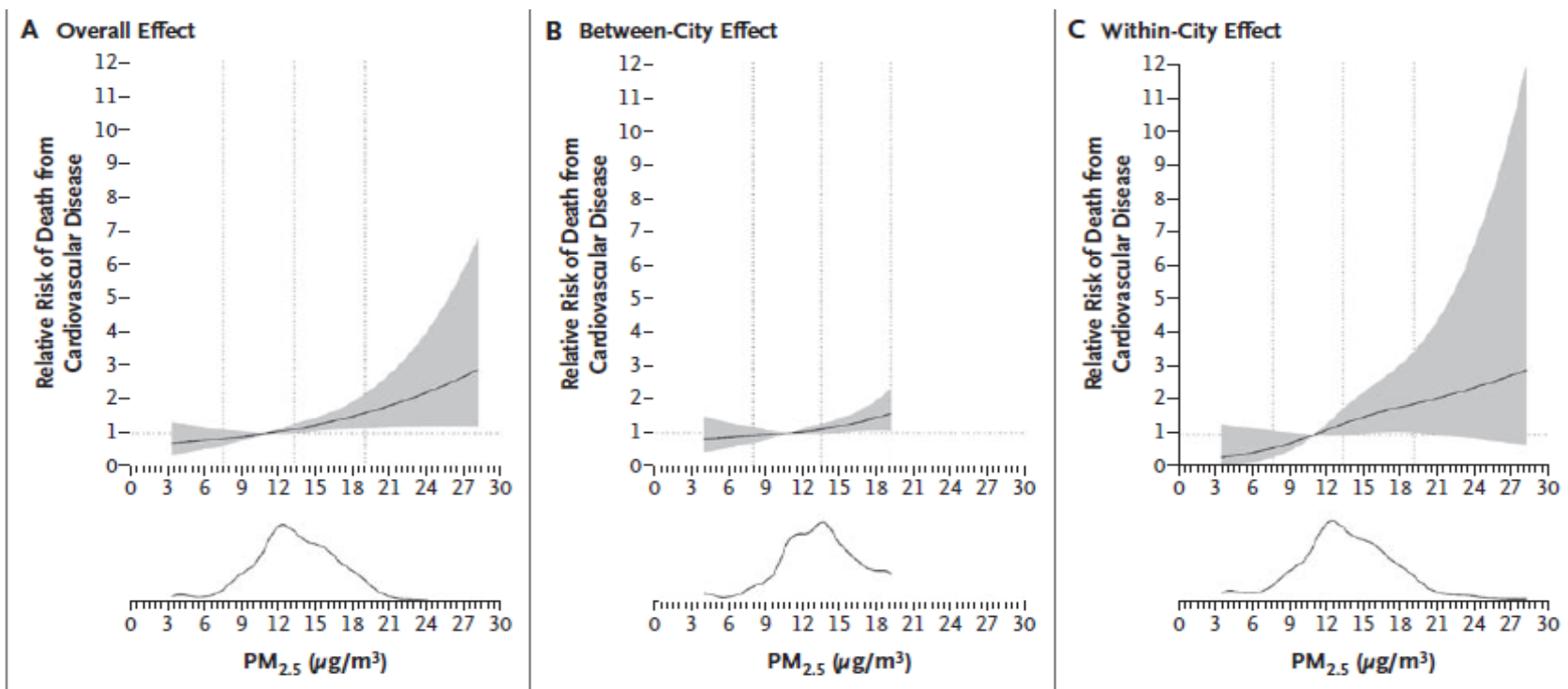
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## Long-Term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women

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- **65.893 post menopausal women**
- **Examination of association between long-term exposure to particulate matter of less than 2.5  $\mu\text{m}$  in aerodynamic diameter ( $\text{PM}_{2.5}$ ) and cardiovascular events**
- **Each increase of 10  $\mu\text{g}$  per cubic meter was associated with a 24% increase in the risk of a cardiovascular event (hazard ratio, 1.24; 95% confidence interval [CI], 1.09 to 1.41) and a 76% increase in the risk of death from cardiovascular disease (hazard ratio, 1.76; 95% CI, 1.25 to 2.47)**





**Figure 1.** Level of Exposure to Fine Particulate Matter and the Risk of Death from Cardiovascular Causes in Women.

The graphs demonstrate the observed relationship between the risk of death from cardiovascular disease and the level of particulate matter of less than 2.5  $\mu\text{m}$  in aerodynamic diameter ( $\text{PM}_{2.5}$ ), including both definite and possible deaths from coronary heart disease or cerebrovascular disease. Panel A shows the overall relationship between the  $\text{PM}_{2.5}$  level and death, Panel B the effects between metropolitan areas, and Panel C the effects within metropolitan areas, with an indicator variable used to adjust for each city. These results suggest a generally linear relationship between exposure and risk, though the 95% confidence intervals (shaded areas) are wide at the extremes of exposure. Risk is depicted in comparison with a reference value of 11  $\mu\text{g}$  per cubic meter. The histogram in each panel illustrates the density of exposure distribution for air pollution. All estimates are adjusted for age, race or ethnic group, educational level, household income, smoking status, systolic blood pressure, body-mass index, and presence or absence of a history of diabetes, hypertension, or hypercholesterolemia.

**The between-city effect appeared to be smaller**  
**than the within-city effect**



# Respiratory and cardiovascular responses to walking down a traffic-polluted road compared with walking in a traffic-free area in participants aged 60 years and older with chronic lung or heart disease and age-matched healthy controls: a randomised, crossover study



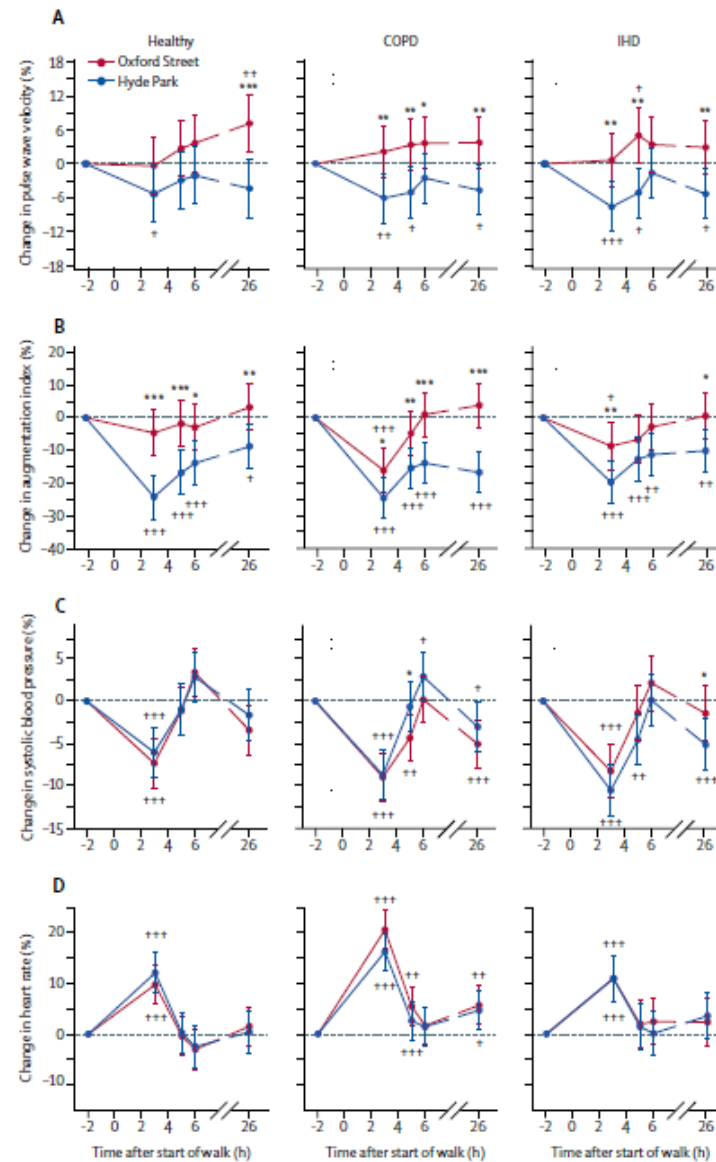
Rudy Sinharay\*, Jicheng Gong\*, Benjamin Barratt, Pamela Ohman-Strickland, Sabine Ernst, Frank J Kelly, Junfeng (Jim) Zhang, Peter Collins, Paul Cullinan, Kian Fan Chung



**Background** Long-term exposure to pollution can lead to an increase in the rate of decline of lung function, especially in older individuals and in those with chronic obstructive pulmonary disease (COPD), whereas shorter-term exposure at higher pollution levels has been implicated in causing excess deaths from ischaemic heart disease and exacerbations of COPD. We aimed to assess the effects on respiratory and cardiovascular responses of walking down a busy street with high levels of pollution compared with walking in a traffic-free area with lower pollution levels in older adults.

- Between October 2012 and June 2014
- 135 participants (men and women aged 60 years), of whom 40 healthy volunteers, 40 individuals with COPD and 39 with ischemic heart disease
- Randomization: 2 hours along a commercial street in London (Oxford Street) or in an urban park (Hyde Park)
- Concentrations of black carbon, NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> and ultrafine particles were higher on Oxford Street than in Hyde Park





**Figure 6:** Pulse wave velocity (A), augmentation Index (B), systolic blood pressure (C), and In heart rate (D) from the baseline (time 0) and at 1 and 2 h after the start of the walk on Oxford Street or In Hyde Park followed by measurements performed back in the laboratory at times indicated after the start of the walk in healthy volunteers and participants with COPD or IHD. Data are percentage changes (95% CI). COPD—chronic obstructive pulmonary disease. IHD—Ischaemic heart disease. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ , comparing Oxford Street with Hyde Park. + $p < 0.05$ , ++ $p < 0.01$ , +++ $p < 0.001$ , compared with timepoint -2 h.



# Respiratory and cardiovascular responses to walking down a traffic-polluted road compared with walking in a traffic-free area in participants aged 60 years and older with chronic lung or heart disease and age-matched healthy controls: a randomised, crossover study



Rudy Sinharay\*, Jicheng Gong\*, Benjamin Barratt, Pamela Ohman-Strickland, Sabine Ernst, Frank J Kelly, Junfeng (Jim) Zhang, Peter Collins, Paul Cullinan, Kian Fan Chung



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**Interpretation** Short-term exposure to traffic pollution prevents the beneficial cardiopulmonary effects of walking in people with COPD, ischaemic heart disease, and those free from chronic cardiopulmonary diseases. Medication use might reduce the adverse effects of air pollution in individuals with ischaemic heart disease. Policies should aim to control ambient levels of air pollution along busy streets in view of these negative health effects.



# **CONCLUSIONS**

- *Nowadays air pollution is considered an additional cardiovascular risk factor*
- *There is a link not only between long-term air pollution exposure and cardiovascular events, but also between short-term exposure and ischemic heart disease*
- *Long term  $PM_{2.5}$  reduction is associated with an increased life expectancy*



***Thank you for your kind attention***

