

# Effects of Air Quality on Cardiovascular Disease

Donald Grandis, M.D,

# A Real Life Case Presentation

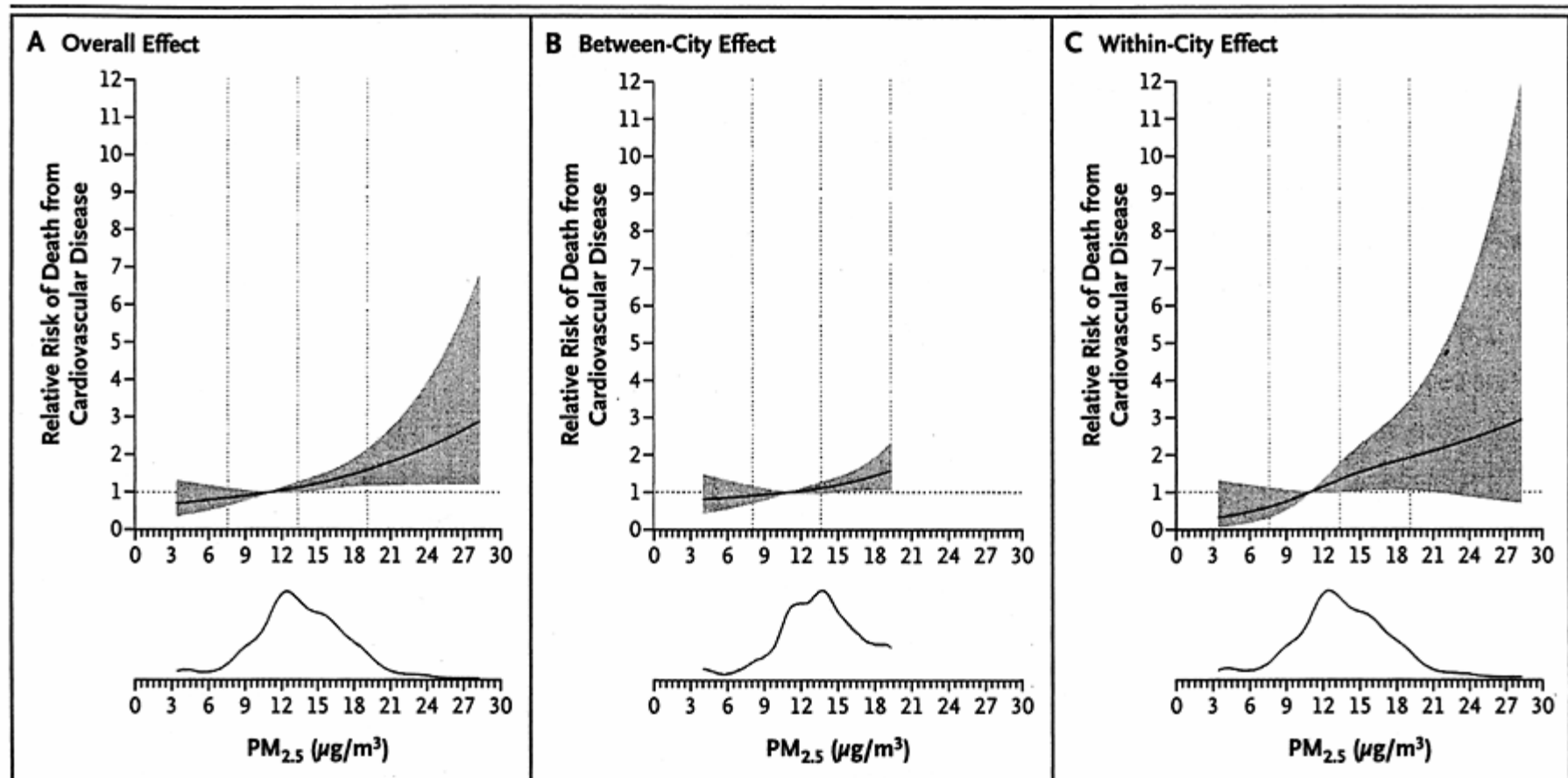
- M.F. is a 64 year old woman with no history of high blood pressure, diabetes mellitus, high cholesterol, or cigarette smoking.
- She developed severe chest pain on the evening of 01/14/08 and presented to the Emergency Department the following morning. The diagnosis of an Acute Myocardial Infarction (heart attack) was made.
- She underwent an emergency coronary angioplasty and has done well since.

# Cardiovascular Disease Facts

- Cardiovascular Disease remains the leading cause of death in the U.S.
- Approx. 800,000 Myocardial Infarctions occur each year in the U.S.
- Annual Cost is \$76 billion.
- Risk factors include age, smoking, high cholesterol, high blood pressure, diabetes mellitus, and male gender.
- 50% of patients have “normal” cholesterol levels and 20% have no known major risk factors.

# Air Pollution as Risk Factor for Cardiovascular Disease

- Dublin, Ireland banned coal sales 1990, reduced black smoke  $35.6\mu\text{g}/\text{mm}^3$  and saw an associated 10.3% annual reduction in cardiovascular mortality.
- Based on over 15 studies worldwide, an increase in  $\text{PM}_{10}$  of  $10\mu\text{g}/\text{mm}^3$  increases cardiovascular mortality 1.4%
- In the US, during 24 hours, for each increase of  $10\mu\text{g}/\text{mm}^3$  in  $\text{PM}_{10}$ , cardiovascular mortality increases 0.2%
- A study in Allegheny County in 2004 found that an increase in  $\text{PM}_{10}$  of  $10\mu\text{g}/\text{mm}^3$  increased the chances of admission for heart failure by 3%.



**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 µm in aerodynamic diameter (PM<sub>2.5</sub>), including both definite and possible deaths from coronary heart disease or cerebrovascular disease. Panel A shows the overall relationship between the PM<sub>2.5</sub> 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 µg 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.

# Allegheny County, Pennsylvania 2007

## Exceedances of the Short-Term Federal Standards, 2007 (through 2<sup>nd</sup> Qtr.)

<b>Pollutant</b>	<b>Site</b>	<b>Date</b>	<b>Concentration</b>	<b>Standard</b>
Ozone	South Fayette	5/30/2007	0.087 ppm (8-hr.)	0.08 ppm
Ozone	Lawrenceville	5/31/2007	0.091 ppm (8-hr.)	0.08 ppm
Ozone	Harrison	8/2/2007	0.099 ppm (8-hr.)	0.08 ppm
Ozone	Harrison	8/3/2007	0.086 ppm (8-hr.)	0.08 ppm
Ozone	Lawrenceville	8/4/2007	0.085 ppm (8-hr.)	0.08 ppm
Ozone	Harrison	8/28/2007	0.087 ppm (8-hr.)	0.08 ppm
Ozone	Lawrenceville	8/29/2007	0.092 ppm (8-hr.)	0.08 ppm
Ozone	Harrison	8/29/2007	0.089 ppm (8-hr.)	0.08 ppm
PM <sub>2.5</sub>	Liberty	18 Days	Max = 56.5 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>
PM <sub>2.5</sub>	N. Braddock	2 Days	Max = 50.0 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>
PM <sub>2.5</sub>	Lawrenceville	2 Days	Max = 45.9 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>
PM <sub>2.5</sub>	Harrison	2 Days	Max = 43.9 µg/m <sup>3</sup>	35 µg/m <sup>3</sup>

All other criteria pollutants were below the short-term federal standards.

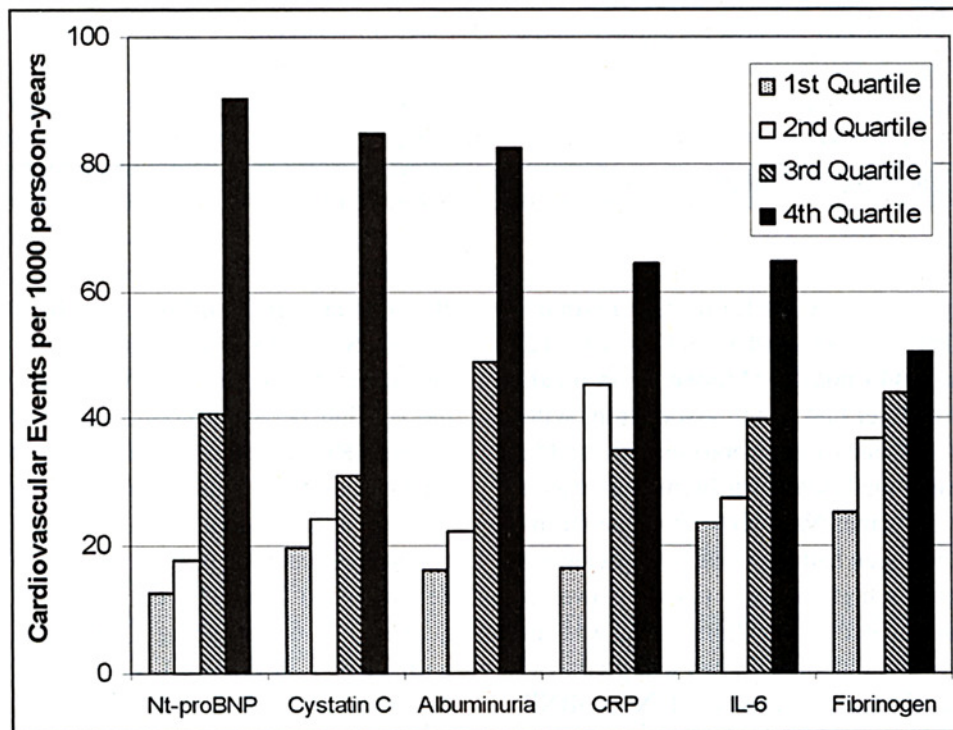
# Limitations

- Relative to other conventional risk factors, the risk of poor air quality causing cardiovascular disease is relatively low for a given individual.
- Studies are associations, not causation.
- Other factors such as lower income , education level, and lifestyle may be more prevalent in those with higher air pollution exposure. These factors might confound the findings.
- “Harvesting”

# Possible Effects of Air Pollution on Human Physiology

- PM<sub>10</sub> particles and smaller are small enough to cross from lungs into blood stream.
- PM<sub>10</sub> particles raise blood pressure.
- PM<sub>2.5</sub> particles raise blood levels of CRP.
- Diesel Exhaust raises blood levels of IL-6.
- PM<sub>2.5</sub> particles raise activation of the nervous system which can lead to heart rhythm abnormalities.
- PM<sub>2.5</sub> particles raise blood levels of fibrinogen.
- PM<sub>2.5</sub> particle exposure increases vascular resistance

# Role of Inflammation on Risk of Cardiovascular Events



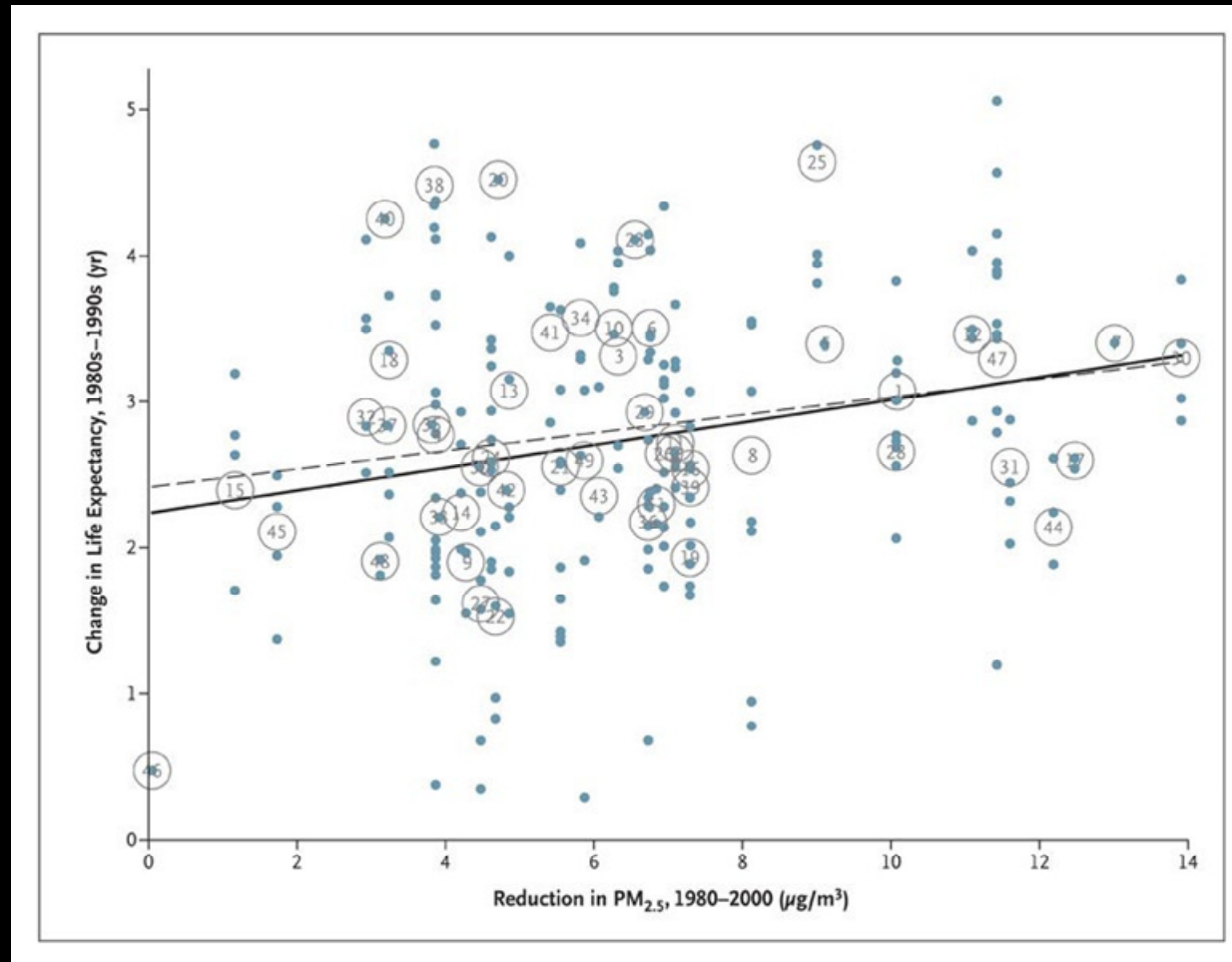
**Figure 1** Cardiovascular event incidence rates per 1000 person-years across quartiles of Nt-proBNP, cystatin C, albuminuria, CRP, IL-6, and fibrinogen. Nt-proBNP = N-terminal prohormone brain natriuretic peptide; CRP = C-reactive protein; IL = interleukin.

(The American Journal of Medicine, Vol. 121, No. 1, January 2008)

**Question: Could Poor Air Quality, by Increasing Inflammation, Blood Pressure, and Tendency to Blood Clotting be an explanation for the unexplained Heart Attack?**

In January 2008, when M.F. suffered her heart attack, the EPA air quality monitors were listed as orange (50 – 100  $\mu\text{g}/\text{mm}^3$ ).

## Changes in Life Expectancy for the 1980s-1990s, Plotted against Reductions in PM<sub>2.5</sub> Concentrations for 1980-2000



Pope C et al. N Engl J Med 2009;360:376-386



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# Conclusion

- As levels of  $PM_{10}$  and  $PM_{2.5}$  increase, the risk of death or hospitalization from cardiovascular disease increases.
- The relative risk of cardiovascular disease due to poor air quality is less than that of conventional risk factors for the nation overall. However, the levels of  $PM_{2.5}$  that are seen in Allegheny County generate risks similar to those seen with conventional risk factors
- Unlike conventional risk factors which affect some of the population, air pollution affects everyone.