Fine & Ultrafine Particles
Fact Summary

How small particles in the air affect our body
Particles

Coarse particles (PM10)

Fine particles (PM2.5)

Ultrafine particles / Nanoparticles (PM0.1)

Reference: www.clinsci.org/content/115/6/175
Fine & Ultrafine Particles can reach into gas exchange region

Reference: Institute for Risk Assessment Sciences University of Utrecht, Netherlands, March 2009
The smaller the particle, the further into the human body it reaches.

Reference: www.cleanairmatters.org/2016/10/standard-for-safer-air/
Penetration of different-sized particles into the human body

Superior Airways of respiration
- Coarse particles: \( D_p < 10 \mu m \)
  - PM10

Inferior Airways of respiration
- Fine particles: \( D_p < 2.5 \mu m \)
  - PM2.5
- Inhalable particle: \( D_p < 1 \mu m \)
- Ultratine particles: \( D_p < 100 \text{ nm} \)
  - Ultrafine PM0.1

Alvéolos
Passage of inhaled ultrafine particles (PM0.1) into human body → extrapulmonary organs

Ultrafine particles in the lung can be translocated into circulation, reaching heart, brain, liver, kidney, immune system, fetus, etc.

Systemic health effects of ultrafine particles

1 Cancer

International Agency for Research on Cancer

Press Release
N° 221

17 October 2013

IARC: Outdoor air pollution a leading environmental cause of cancer deaths

Lyon/Geneva, 17 October 2013 – The specialized cancer agency of the World Health Organization, the International Agency for Research on Cancer (IARC), announced today that it has classified outdoor air pollution as carcinogenic to humans (Group 1).

After thoroughly reviewing the latest available scientific literature, the world’s leading experts convened by the IARC Monographs Programme concluded that there is sufficient evidence that exposure to outdoor air pollution causes lung cancer (Group 1). They also noted a positive association with an increased risk of bladder cancer.

Particulate matter, a major component of outdoor air pollution, was evaluated separately and was also classified as carcinogenic to humans (Group 1).

Each 10 μg/m³ increase in PM10 concentrations was associated with a 22% increase in lung cancer.

Each 5 ug/m³ increase in PM2.5 concentrations was associated with a 18% increase in lung cancer.

Reference: Raaschou-Nielsen et al, the Lancet Oncology (2013)
In a 26-year prospective study of a large cohort of lifelong never-smokers, each 10 μg/m³ increase in PM2.5 concentrations was associated with a 15–27% increase in lung cancer mortality.

Michael J. Thun
University of Ottawa Canada
Low-Concentration PM$_{2.5}$ and Mortality: Estimating Acute and Chronic Effects in a Population-Based Study

Lihua Shi, Antonella Zanobetti, Itai Kloor, Brent A. Coull, Petros Koutrakis, Steven J. Melly, and Joel D. Schwartz

Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, Massachusetts, USA; Department of Geography and Environmental Development, Ben-Gurion University of the Negev, Beer Sheva, Israel; Department of Biostatistics, Harvard T.H. Chan School of Public Health, Boston, Massachusetts, USA

| Table 2. Percent increase in mortality (95% CI) for a 10-µg/m$^3$ increase for both short-term and long-term PM$_{2.5}$. |
|---|---|---|---|---|
| **PM$_{2.5}$ exposure** | **Model** | **Percent increase** | **p-Value** |
| With mutual adjustment | | | |
| Short-term PM$_{2.5}$ | Low daily exposure$^a$ | 2.14 ± 0.81 | < 0.001 |
| | Full cohort | 2.14 ± 0.75 | < 0.001 |
| | Long-term PM$_{2.5}$ | Low chronic exposure$^b$ | 9.28 ± 8.88 | 0.032 |
| Without mutual adjustment | Full cohort | 7.52 ± 5.73 | 0.007 |
| Short-term PM$_{2.5}$ | Low daily exposure$^a$ | 2.07 ± 0.80 | < 0.001 |
| | Full cohort | 2.08 ± 0.76 | < 0.001 |
| | Long-term PM$_{2.5}$ | Low chronic exposure$^b$ | 7.16 ± 8.75 | 0.109 |
| | Full cohort | 6.46 ± 5.69 | 0.026 |

The full cohort analysis had 551,024 deaths.
$^a$The analysis was restricted only to person time with daily PM$_{2.5} < 30$ µg/m$^3$ (422,637 deaths). $^b$The analysis was restricted only to person time with chronic PM$_{2.5} < 10$ µg/m$^3$ (268,050 deaths).

Reference: Shi et al, Environ Health Perspect (2016)
Cancer Mortality Risks from Long-term Exposure to Ambient Fine Particle

Chit Ming Wong¹, Hilda Tsang¹, Hak Kan Lai¹, G. Neil Thomas², Kin Bong Lam³, King Pan Chan¹, Qishi Zheng¹, Jon G. Ayres⁴, Siu Yin Lee⁵, Tai Hing Lam¹, and Thuan Quoc Thach¹

Abstract

Background: Few studies have assessed long-term effects of particulate matter (PM) with aerodynamic diameter < 2.5 μm (PM_{2.5}) on mortality for causes of cancer other than the lung; we assessed the effects on multiple causes. In Hong Kong, most people live and work in urban or suburban areas with high-rise buildings. This facilitates the estimation of PM_{2.5} exposure of individuals, taking into account the height of residence above ground level for assessment of the long-term health effects with sufficient statistical power.

Methods: We recruited 66,820 persons who were ≥65 in 1998 to 2001 and followed up for mortality outcomes until 2011. Annual concentrations of PM at their residential addresses were estimated using PM_{2.5} concentrations measured at fixed-site monitors, horizontal–vertical locations, and satellite data. We used Cox regression model to assess the HR of mortality for cancer per 10 μg/m³ increase of PM_{2.5}.

Results: PM_{2.5} was associated with increased risk of mortality for all causes of cancer [HR, 1.22 (95% CI, 1.11–1.34)] and for specific causes of cancer in upper digestive tract [1.42 (1.06–1.89)], digestive accessory organs [1.35 (1.06–1.71)] in all subjects; breast [1.80 (1.26–2.55)] in females; and lung [1.36 (1.05–1.77)] in males.

Conclusions: Long-term exposures to PM_{2.5} are associated with elevated risks of cancer in various organs.

Impact: This study is particularly timely in China, where compelling evidence is needed to support the pollution control policy to ameliorate the health damages associated with economic growth. Cancer Epidemiol Biomarkers Prev; 25(5): 1–7. ©2016 AACR.

Reference: Wong et al, Cancer Epidemiol Biomarkers (2016)
Exposure to particulate air pollutants associated with numerous cancers

Posted on 29 Apr 2016

Researchers have found that long-term exposure to environmental pollutants was associated with increased risk of mortality for many types of cancer in an elderly Hong Kong population.

Air pollution led to alterations in about 2,800 points on DNA

“Ultrafine particles cause systemic oxidative stress with damage to DNA and no apparent compensatory up-regulation of DNA repair within 24 hr.”

Elvira Vaclavik Bräuner, University of Copenhagen, Denmark

Reference: Bräuner et al, Environmental Health Perspectives (2007)
2. Cardiovascular Diseases

FACTS

Danger in the Air
Air Pollution and Cardiovascular Disease

OVERVIEW
The air we breathe shouldn’t pose a serious threat to our health, but unfortunately the polluted air in the U.S. is doing just that. Air pollution, which contains tiny particles and invisible gases, comes from sources such as power plant and vehicle emissions, fires, and even windblown dust. These particles and gases can cause an array of health problems, including acute and chronic cardiovascular conditions.

Cardiovascular disease (CVD) is the number one killer of Americans, accounting for one in every three deaths, and sadly the state of our air is directly contributing to the problem. Air pollution levels across the U.S., particularly in cities, are periodically high enough to trigger potentially life-threatening heart problems. That’s the bad news. However, reducing exposure to dangerous pollutants can decrease the risk of cardiovascular events. The American Heart Association advocates for measures that reduce Americans’ exposure to air pollution, and for more research on the impact of air pollution on the public’s health. The American Heart Association

Fossil fuel emissions are a major source of air pollution, including fine particulate matter that may contain arsenic, selenium, and sulfates from sulfur dioxide. These types of \( PM_{2.5} \) are generated from burning materials such as coal, oil, diesel, and gasoline, and from high-temperature industrial processes at steel mills and power plants.

Because \( PM_{2.5} \) can remain in the atmosphere for long periods of time and travel hundreds or even thousands of miles from its source, the majority of the U.S. population may be exposed to \( PM_{2.5} \). Exposure is of particular concern for individuals who are already at risk for CVD or its complications, such as the elderly or those with a preexisting heart condition. In sensitive populations, exposure to \( PM_{2.5} \) for even a few hours or days can trigger cardiovascular disease-related deaths from heart attack, stroke, arrhythmia, sudden cardiac arrest, and heart failure. Short-term increases in \( PM_{2.5} \) levels lead to the early death of tens of thousands of Americans every year. Longer-term exposure over a few years further increases the risk of cardiovascular mortality and decreases life expectancy by months to years.

Reference: https://www.heart.org/idc/groups/heart-public/@wcm/@adv/documents/downloadable/ucm_463344.pdf
Positive associations of stroke mortality with current- and previous-day levels of fine particles (6.9%) ultrafine particles (8.5%), and carbon monoxide (8.3%)
The risk of developing ischemia during exercise was significantly elevated at 2 days after exposure to increased environmental levels of fine and ultrafine particulate air pollution.
Higher levels of ambient air pollution lead to an inflammatory response in patients with cardiovascular diseases and provide a possible explanation for the observed association between air pollution and cardiovascular morbidity.
Association between PM and risk of cardiac ischemia and arrhythmias, increased blood pressure, decreased heart rate variability, and increased circulating markers of inflammation and thrombosis.
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Fine & Ultrafine Particles
Fact Summary

How small particles in the air affect our body
Ultrafine Removal

✓ Monitor
✓ Remove
✓ Always keep “Good” level by AI
### PM2.5 Concentration

**Check Indoor Air Quality in Your Room according to US EPA standard**

<table>
<thead>
<tr>
<th>PM2.5 Concentration</th>
<th>Air Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD</td>
<td>0 - 12 mg/m³</td>
</tr>
<tr>
<td>MODERATE</td>
<td>13 - 35 mg/m³</td>
</tr>
<tr>
<td>UNHEALTHY</td>
<td>36 - 50 mg/m³</td>
</tr>
<tr>
<td>UNHEALTHY</td>
<td>51 - 150 mg/m³</td>
</tr>
<tr>
<td>VERY UNHEALTHY</td>
<td>151 - 250 mg/m³</td>
</tr>
<tr>
<td>HAZARDOUS</td>
<td>&gt; 250 mg/m³</td>
</tr>
</tbody>
</table>

**Example:**
- **26.5 mg/m³:** Good
- **28 mg/m³:** Moderate
- **30 mg/m³:** Unhealthy
- **52 mg/m³:** Very Unhealthy
Ultrafine Monitoring

PM2.5 Level According to US EPA Classification
US EPA’s Air Quality Index (AQI)
24-hr PM2.5 (ug/m³)

User can remotely check room’s Indoor Air Quality Level from anywhere in the world
Ultrafine Monitoring
Ultrafine Removal

Pre-Filter
Collect coarse dust particles, such as road dust, animal hair, pollen, etc.

Large area for Saijo Denki-patented electrostatic air purification system designed for Air-Conditioning application

ULTRAFINE TECHNOLOGY Air Purification System
Collect up to 99.9% of fine (PM2.5) and Ultrafine (PM0.3) particles.

High-Efficiency Evaporator
Design for energy saving and low noise.

Ozone Filter
High-Efficiency air purification system, widely used by medical industry to kill pathogens up to 3,225 times more efficient than antoine.

PM 2.5 Sensor
Designed to ensure good air flow from inlet passing through PM 2.5 sensor for accurate PM 2.5 level.
6. Result

The residual PM$_{0.1}$ concentration and the removal rate of PM$_{0.1}$ is shown below.

![Graph showing PM$_{0.1}$ concentration reduction over time](image)

Figure 1. The reduction of PM$_{0.1}$ concentration with the testing air purifier

99.99% Ultrafine Particle Removal within 120 minutes
Ultrafine Removal

JET Test Report by Model Ultrafine

Test Report
Ultrafine Particles Concentration Reduction
Japan Electrical Testing Laboratory (Thailand) Co., Ltd.
(JET Thailand)

Model: High Efficiency Impactor (HEI) ULTRAFINE TECHNOLOGY, AS M72F-0-0FU1, ULTRAFINE TECHNOLOGY

Tests were performed by SAIJO DENKI International Co., Ltd.

The reduction of PM2.5 concentration with the testing air purifier

In PM2.5 testing room, the concentration of ultrafine particles has been reduced by the air purifier by 99.89% in 45 minutes, and within 90 minutes down to 99.95%.

The time used on removing particles 99% in 22.28 testing room (based on calculation with the same equipment in HEI solution, the test is less than or equal to 86 minutes with reference to JEMAN200 and IEEE209 test methods).

Conclusions: Ultrafine Technology can be used as a promising tool to reduce ultrafine particles in the air, which are considered as dangerous in human, according to WHO.

Approved by: [Signature]
Date: [Date]

SAIJO DENKI
Turbo APS Electro-Filter

Air in

Air out

0.01 um Filtration Efficiency
Monitor & Control Ultrafine Particles using Smart Phone from anywhere in the world

99.99% Ultrafine Particle Removal within 120 minutes

AUTO mode – Keep “Good” Indoor Air Quality level in your room all the time
**Killing Pathogens by Ozone**

1. **The faster and more efficient way of destroying microorganisms**

2. **Capable of killing pathogens 3,125 times faster than chlorine**

3. **Used in most hospital operating rooms to prevent infections**
US Food and Drug Administration (FDA) and Environmental Protection Agency (EPA) approved that ozone can destroy pathogenic viruses, bacteria, fungi, and other airborne particles up to 99.992%.

In Europe, ozone was widely used in medical sectors to cure diseases especially in Germany, Russia, France, and Italy.

Ozone-Based Disinfection Technology was used in Canada to destroy MRSA pathogens.
Ozone in Medical Application

By Turbo A.P.S magnetic field

Generating oxide ions ($O^{2-}$) from oxygen molecules ($O_2$)
Ozone in Medical Application

Oxygen ions combined together to generate OZONE molecules ($O_3$)
Ozone in Medical Application

OZONE molecules (O₃) kills odor, pathogenic microbes i.e. viruses, bacteria, fungi, etc.
Ozone in Medical Application

Is it safe to use ozone purification at home?

According to ozone concentration standard (IEC335-2-65), OZONE produced in Saijo Denki air-conditioners is 10 times safer than the international standard.
The smaller the particle, the further into the human body it reaches.

Reference: www.cleanairmatters.org/2016/10/standard-for-safer-air/
Thank you

Fine & Ultrafine Particles  Fact Summary