Health impacts of diesel emissions

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Diesel exhaust particles

- DEP consist of a carbon core surrounded by trace metals, quinones, VOCs
- The solid particulate fraction consists mainly of very small particles typically <1 μm in size
- Fine and ultrafine particles (UFP)
- Elemental carbon or organic carbon or soot used as a surrogate for diesel in epi studies
Concern with diesel exhaust particles

- Small size allows for high deposition rate into the airways
- High surface area allows better adsorption of other chemicals
How important are diesel emissions to health?

IARC, 2013

Major report deeming ambient air pollution as a cause of cancer (Group 1)
PM also separately classified as carcinogenic to humans (Group 1)

IARC, 2012

Reclassified diesel exhaust as a carcinogen

International Agency for Research on Cancer

WHO confirms diesel fumes carcinogenic

Press Release

IARC: DIESEL ENGINE EXHAUST CARCINOGENIC

Lyon, France, June 12, 2012 -- After a week-long meeting of international experts, the International Agency for Research on Cancer (IARC), which is part of the World Health Organization (WHO), today classified diesel engine exhaust as carcinogenic to humans (Group 1), based on sufficient evidence that exposure is associated with an increased risk for lung cancer.

Background

In 1989, IARC classified diesel exhaust as probably carcinogenic to humans (Group 2A). An Advisory Group which reviews and recommends future priorities for the IARC Monographs Program had recommended diesel exhaust as a high priority for re-evaluation since 1986.

There has been mounting concern about the cancer-causing potential of diesel exhaust, particularly based on findings in epidemiological studies of workers exposed in various settings. This was re-emphasized by the publication in March 2012 of the results of a large US National Cancer Institute/National Institute for Occupational Safety and Health study of occupational exposure to such emissions in refineries.

Evaluation

The scientists...
What does this mean?

The WHO classifies the cancer-causing potential of various substances into four groups, depending on the evidence available in both humans (epidemiological and chamber studies) and animals (toxicological studies):

Group 1 is used when a substance causes cancer in humans
Group 2A is used when a substance ‘probably’ causes cancer in humans
Group 2B is used when a substance ‘possibly’ causes cancer in humans
Group 3 is used when a substance is not classifiable in terms of its cancer-causing properties in humans because the evidence is inadequate
Group 4 is used when a substance is ‘probably not’ a cause of cancer in humans
Why?

• Decision based on findings from epidemiological studies of workers exposed to diesel fumes.
• Recent large cohort study (US National Cancer Institute and NIOSH), published in March 2012, of occupational exposure to diesel exhaust in 12,315 US miners.
• Increased the risk of dying from lung cancer (1.26, 95% CI: 1.09 to 1.44).
• Case-control study, in this group (comparing 198 miners who had died from lung cancer with 562 miners who were alive at the time the ‘case’ died), found risk of lung cancer in workers increased with the length of exposure time – dose response.
• Studies were in heavily exposed workers to diesel fumes, however WHO recommends action to reduce exposure to diesel exhaust fumes should encompass both highly exposed workers and the general population.
Other views?

- **National Toxicology Program (NTP) (US)** (includes the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA). Classified exposure to diesel exhaust particulates as “reasonably anticipated to be a human carcinogen,” based on limited evidence from studies in humans and supporting evidence from lab studies.

- The US **Environmental Protection Agency (EPA)** classifies diesel exhaust as “likely to be carcinogenic to humans.”

- The **National Institute for Occupational Safety and Health (NIOSH)** has determined that diesel exhaust is a “potential occupational carcinogen.”
Other health effects?

- **Acute exposures:**
  - can cause irritation to the eyes, nose, throat, and lungs, nausea
  - cough, lung function changes, and asthma exacerbations
  - increase in inflammatory markers
  - act as adjuvants to allergen to increase allergic response (chamber studies)

- **Chronic exposures**
  - Cough, sputum production, lung function decrements
  - increased lung cancer risk

- USEPA has set a Reference Concentration for diesel exhaust (includes DPM) of 5 ug/m3.

- The US Health Effects Institute-Panel (2014) to report (in 18 mths time) on whether there is sufficient data from recent studies to conduct a quantitative risk assessment for general exposures (that is lower dose levels)
How important is air pollution to health?


- DALYs-includes mortality and morbidity effects

Notable in that it is an unavoidable exposure & relevant to the whole population

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Mean rank (95% UI)</th>
<th>% change (95% UI)</th>
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<tbody>
<tr>
<td>1 High blood pressure</td>
<td>1-1 (1-2)</td>
<td>27% (19 to 34)</td>
</tr>
<tr>
<td>2 Smoking (including SHS)</td>
<td>1-9 (1-2)</td>
<td>3% (-5 to 11)</td>
</tr>
<tr>
<td>3 Household air pollution</td>
<td>4-6 (3-7)</td>
<td>-37% (-44 to 11)</td>
</tr>
<tr>
<td>4 Low fruit</td>
<td>5-0 (4-8)</td>
<td>29% (25 to 34)</td>
</tr>
<tr>
<td>5 Alcohol use</td>
<td>5-1 (3-7)</td>
<td>32% (17 to 47)</td>
</tr>
<tr>
<td>6 High body-mass index</td>
<td>6-1 (4-8)</td>
<td>82% (71 to 95)</td>
</tr>
<tr>
<td>7 High fasting plasma glucose</td>
<td>6-6 (5-8)</td>
<td>58% (43 to 73)</td>
</tr>
<tr>
<td>8 Childhood underweight</td>
<td>8-5 (6-11)</td>
<td>-61% (-66 to -55)</td>
</tr>
<tr>
<td>9 Ambient PM pollution</td>
<td>8-7 (7-11)</td>
<td>-7% (-13 to -1)</td>
</tr>
<tr>
<td>10 Physical inactivity</td>
<td>10-0 (8-12)</td>
<td>0% (0 to 0)</td>
</tr>
</tbody>
</table>

Figure 3: Global risk factor ranks with 95% UI for all ages and sexes combined in 1990, and 2010, and percentage change PM=particulate matter. UI=uncertainty interval. SHS=second-hand smoke. An interactive version of this figure is available online at http://healthmetricsandevaluation.org/gbd/visualizations/regional.
Knowledge gaps: concentration response functions (CRFs) of particulate matter (PM) at low and at very high (peak) levels

- Is there a threshold of effect to PM$_{2.5}$?

PM$_{2.5}$ short-term effects
- Substantial evidence of associations at very low levels of PM$_{2.5}$
- No observed threshold of effect

Concentration-response Relation Between PM$_{2.5}$ and Daily Deaths

Schwartz EHP 2002