Diesel health effects

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Sumeet Saksena, Ph.D.

The East-West Center

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What is diesel exhaust (DE)?

- Most important: fine particulate matter, PM 2.5 (soot) and ultrafine particles < 0.1 microns
  - Elemental carbon core, large adsorbing surface area. Organics account for 20-40% of the particle weight
  - Easily penetrates the deep lung
- Gases
  - Oxides of nitrogen (lead to photochemical smog)
  - Sulfur compounds
  - Aldehydes
  - Benzene
  - Polycyclic aromatic hydrocarbons (PAH)

Factors influencing chemical composition of DE

- Engine type: heavy-duty vs. light-duty
- Engine operating conditions: idle, accelerate, decelerate
- Fuel formulations: high/low sulfur fuel
- On-road vs. nonroad engines

DE's contribution to ambient air quality

- Nationwide: 6% of PM2.5 was DE (1998)
- Urban areas: 10- 36%

Health effects

- Acute (short-term exposure) effects
- Chronic (long-term exposure) noncancer effects
- Chronic (long-term exposure) carcinogenic effects

Acute (short-term exposure) effects

- Acute irritation
  - Eye
  - Throat
  - Bronchial
- Neurophysiologic symptoms
  - Lightheadedness
  - Nausea
- Respiratory symptoms
  - Cough
  - Phlegm
- Exacerbation of allergies and asthma

Chronic (long-term exposure) noncancer effects

- Inflammation of lung tissues
- Particulate matter is known to lead to bronchitis and heart diseases

Chronic (long-term exposure) carcinogenic effects

- “Likely to be carcinogenic to humans by inhalation”.
- Evidence mainly from occupational groups studies
- 70% of cancer risk from air pollution in California stems from DE (CA Air Resources Board)

Public health impacts

- Nationwide, particulate matter from diesel emissions causes 15,000 premature deaths every year.
- EPA estimates that a $100 million voluntary diesel retrofit program would create $2 billion in health benefits from reduced premature deaths, hospital visits, and other costs associated with diesel emissions exposure

Health effects: Uncertainties

- Evidence based on old engine technologies
- Applicability of high dose situations (as for workers) to low dose situations (as for the public)
- Lack of actual exposure data, even for workers
- Susceptibilities of different population groups (elders, children)
  - Different concentrations, breathing rates, particle retention in lung tissues

Improving the exposure data

- Exposure depends on:
  - Population group (who exactly is being exposed?)
  - Concentration in a specific place near a person
  - Time spent in the polluted environment

Traditional roof-top station

Limitations of roof-top fixed-site monitoring

- Pollutants dilute exponentially with increase in height owing to wind speed
- Un-validated assumption that roof-top concentrations are well correlated, spatially and temporally, with road-level concentrations
- Does not consider the fact that the time spent on the road is different across commuters

Monitoring in a bus

Monitoring on a motorcycle

Results for PM10

(micrograms/m3)

24-h standards: WHO = 50 and VN = 150

	Bus	Car	Motorcycle	Walking	All
Mean	262	408	580	495	455
Coefficient of Variation (%)	45	59	34	38	50
Geometric mean	242	343	547	460	397
Geometric standard deviation	1.46	2.07	1.38	1.32	1.56

Comparison of Urban Air Quality
In terms of fine particles (PM10)

City	Air Quality (micrograms/m3)
Asian mega-cities (Beijing, Delhi, Ho Chi Minh, Dhaka, Jakarta, Bangkok)	200
'Dirtiest' US cities (S California, Pittsburg)	30-50
Honolulu	15
Indian standard	60
US standard	50

Comparison of roof-top vs. road-level

- Carbon monoxide was 4 times higher at the road level compared to the roof-top

Popular road-side cafes

Monitoring in roadside cafes

Statistic	PM10 (µg/m3) 24-h standards: WHO = 50 and VN = 150		CO (ppm) 30-minute WHO standard = 50 ppm; 24-h VN = 5	
	Giai Phong road	Pham Van Dong road	Giai Phong road	Pham Van Dong road
Mean	404	617	3.2	11.3
Coefficient of variation (%)	18	32	75	8
Geometric mean	400	591	2.8	11.3
Geometric standard deviation	1.14	1.53	1.5	1.09

Conclusions

- Diesel exhaust is a ‘likely’ carcinogenic
- New evidence is needed based on
  - improvements in engine technology
  - Actual exposure data of workers and general public