

Health impact of new generation
pollutants:
Ozone

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The Problem of Ozone Air Pollution

- In India, monitoring of ozone in the ambient air is not done on a regular basis as it is done for particulates, sulphur dioxide and oxides of nitrogen
- Our present concerns about the adverse effects of air pollution have been related to the particulates
- However, the limited data available on levels of ozone in the ambient air in Delhi shows that the concentrations often exceed this limit

Where does Ozone come from?

- Ozone is a byproduct of the action of sunlight on oxides of nitrogen and VOC that are emitted in vehicular exhaust
- With the ever-increasing number of vehicles, ozone air pollution already constitutes a major problem in India as well and is going to increase future

Good Ozone & Bad Ozone

Good Ozone

- The ozone layer 10 - 30 miles above the earth protects life on earth from the sun's harmful ultraviolet rays

Bad Ozone

- Closer to earth, ozone is an air pollutant that can be harmful. It is created and hangs around in the layer of air near the ground

Harmful effects: Acute

Irritates the Respiratory System

- Coughing
- Throat irritation
- Uncomfortable sensation in the chest

These symptoms can last for a few hours after exposure to ozone and may even become painful

Harmful effects: Acute

- Reduces “Lung Function”
 - volume of air that we draw in when we take a full breath and (restrictive)
 - speed at which we are able to blow it out (obstructive)
- Difficulty to breathe deeply and vigorously
 - Uncomfortable breathing - dyspnoea
 - More rapid and shallow breaths than normal during an exercise

Harmful effects: Acute

Aggravates Asthma

- Increased frequency and severity of symptoms
- Increased use of medication
- Worsening of lung function
- Increases sensitivity to allergens

Harmful effects: Acute

- **Proximal:** Inflames and damages the epithelial lining of the Lung
- **Distal:** Damages the cells that line the air spaces in the lung

Harmful effects



Healthy Airways



Airways exposed to Ozone

Harmful effects: Chronic

- Long-term effects are less well-established
- Airway injury, inflammation, and repair continue to occur during repeated short-term exposure and may permanently injure the lung
- Repeated ozone impacts on the developing lungs of children may lead to reduced lung function as adults
- Induction of new asthma: some evidence of increased allergies

Effect of Ozone exposure on development of asthma in experimental model

Chhabra et al Indian J Med Res.
2010 (Jul);132:87-93.

Objectives

- To study the effects of exposure to ambient concentrations of ozone on induction of asthma in guinea pigs
- To study the oxidant-antioxidant balance in allergen-induced asthma and the effect of exposure to ozone on it
- To evaluate the protective effect of dietary supplementation with antioxidant vitamins - alpha-tocopherol and ascorbic acid on the Ozone-Allergen interaction

Material and Methods

- Study approved by Institutional Animal Ethics Committee
- Male guinea pigs (250-350g)
- Baseline bronchial reactivity to histamine measured
- Animals were sensitized with ovalbumin and divided into three groups, and one control was taken:
 - *Group A (Nonsensitized)*. Control group without any intervention
 - *Group B (Sensitized)*. Animals sensitized to ovalbumin
 - *Group C (Sensitized + Ozone)*. Animals sensitized to ovalbumin and also received daily inhalation of ozone, 0.12 ppm for 2 hours
 - *Group D (Sensitized + Ozone + Diet)*. Animals with intervention as in Group C. Also received a diet supplemented with vitamin C (2mg/Kg body wt) and E (7 IU/Kg Body wt)
- The study parameters were evaluated at 4 weeks

Effect of Ozone on Physiological Response to Allergen

In sensitized animals exposed to ozone, there was:

- a greater increase in bronchial reactivity
- enhanced effect of allergen inhalation producing a greater early bronchospasm
- A more sustained late bronchospastic response
- These observations suggest that sensitized animals had a more intense response to allergen challenge after ozone inhalation

Effect of Ozone on Biochemical Response to Allergen

In sensitized animals exposed to ozone, there was:

- Greatest disturbance in oxidant-antioxidant balance
 - Increased lipid peroxidation
 - Increased generation of superoxide radicals by BAL cells
 - Decreased Superoxide dismutase
 - More intense inflammatory response to allergen challenge

Effect of addition of vitamins E and C on ozone-exposed animals

- Prevented post-sensitization increase in bronchial reactivity
- Reduced early bronchospastic response after ovalbumin challenge
- Reduced late bronchospastic response after ovalbumin challenge
- These results show that Vitamin E and C largely countered the physiological effects of ozone

Effect of addition of vitamins E and C on ozone-exposed animals

- Less disturbance in oxidant-antioxidant balance
 - lesser lipid peroxidation than non-diet supplemented animals
 - lipid peroxidation similar to sensitized animals
 - Lack of decrease in Superoxide dismutase as compared to non-diet supplemented animals
 - Less intense inflammatory response to allergen challenge
 - These results show that Vitamin E and C largely countered the biochemical effects of ozone

Conclusions of Ozone Study

- Current levels of ambient ozone are likely to aggravate the response of allergic bronchial asthma patients to allergen inhalation
- Likely mechanism is a potentiation of oxidative stress
- Dietary supplementation with vitamin E and C may have a protective role against the allergen-ozone interaction

What are the harmful levels?

- The lowest concentration at which effects are observed depends upon
 - the level of activity
 - the duration of exposure
 - the sensitivity of each individual to ozone

 - Thus, effects can occur at 40, 80 or 120 ppb
 - National Ambient Air Quality Standards 2009:
 - 8 hrs, 100 $\mu\text{g}/\text{m}^3$ (50 ppb)
 - 1 hr, 180 $\mu\text{g}/\text{m}^3$ (90 ppb)

Adverse health effects of air pollution: Beyond The Lungs

- Cardiovascular system
- Systemic inflammation

- Pro-inflammatory
- Prothrombotic
- Pro-atherosclerosis
- Arrhythmogenic

