

INDOOR AIR POLLUTION: DEVELOPING COUNTRIES VERSUS DEVELOPED COUNTRIES*

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INTRODUCTION:

In the last several years, a growing body of scientific evidence has indicated that, the air within homes & other buildings can be more seriously polluted than the outdoor air even in the largest & most industrialized cities. The people who may be exposed to indoor air pollutants for the longest period of time are often those most susceptible to the effects of indoor air pollution.

CAUSES:

- Indoor pollution sources that release gases or particles into the air
- Inadequate ventilation can increase indoor pollutant levels by not bringing outdoor air to dilute emission from indoor sources & by not carrying indoor pollutants out of the home.
- High temperature & humidity levels can also increase concentrations of some pollutants.

POLLUTANT SOURCES:

- Combustion sources such as oil, gas, kerosene, coal, wood
- Tobacco products
- Building materials
- Asbestos containing insulation
- Wet or damp carpet
- Cabinetry or furniture made of certain pressed wood products
- Products for household cleaning & maintenance, personal care or hobbies
- Central heating & cooling system & humidification devices
- Outdoor sources such as radon, pesticides & outdoor air pollution

However, indoor pollutants sources differ from house to house, urban to rural sector & country to country.

I. INDOOR AIR QUALITY IN DEVELOPING COUNTRIES: (with special reference to India)

In India, air pollution particularly in rural households has so far been neglected. It is estimated that, 82% of sulphur dioxide (SO₂), 38% of nitrogen dioxide (NO₂), 88% of volatile organic compounds (VOCs) & 96% particulate matter (PM) emissions come from the household sector here¹.

Use of biomass fuels for cooking is the primary source of Indoor pollution & more than three quarters of Indian households use such fuels². Moreover, unprocessed biofuels such as cow dung, fuel wood & crop residues are burnt within the kitchen. Two major vulnerable groups are women & children, who spend large amount of time within the home & thereby they experience the worst health effects.

Unlike the highly visible pollution from vehicles or smokestacks, which is heavily diluted by the time it travels from the source to the air we breathe, domestic pollution due to biomass burning is inhaled much closer to the source & in much higher concentrated levels.

It has been found that, compared to modern cooking fuels like kerosene & Liquefied Petroleum Gas (LPG), biofuels generate 10-100 times more respirable particles per meal owing to their low thermal & heat-transfer efficiencies. Biofuel combustion is also responsible for the emission of pollutants such as sulphur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO), suspended particulate matter (SPM) & polycyclic aromatic hydrocarbons (PAHs).

HEALTH EFFECTS:

1. BLINDNESS:

Eye problems are not uncommon in India considering that one-third of global cataract occur in India³ & cataract are responsible for at least 50% of complete blindness worldwide⁴. The findings of this research suggest that, prevalence of blindness in India could be significantly reduced by decreasing people's exposure to smoke from biofuel combustion.

Researchers found that, persons living in households using biomass as the primary source of cooking fuels had 1.24 times the rate of complete or partial blindness than those using cleaner fuels.

2. DEPRESSION OF IMMUNOGLOBULIN LEVELS:

Indoor air pollution can affect the immune systems of newborns making them more susceptible to illness. A 1995 study of infants from tribal families in east India found that, newborns exposed to indoor air pollution had higher levels of gastro-intestinal tract & respiratory tract infection than unexposed infants⁵.

3. RESPIRATORY DISEASE:

Around 5 million children under the age of 5 die of respiratory disease every year in developing countries⁶. Levels of indoor air pollution are significantly correlated with acute respiratory infections in infants & must be studied as a risk factor in child survival⁷.

Chronic or long-term exposure to respiratory irritants, namely, NO_x, SO₂ & PM is believed to be the chief cause of respiratory damage. Studies conducted in early 1980s found a higher occurrence of chronic bronchitis & cor pulmonale in rural women exposed to chulhas fuelled with cow dung cakes & firewood⁸. Even healthy women in rural areas have found to have lower ventilator capacity compared to urban females.

In developing countries, despite the fact that, men smoke much more heavily than women, both groups are equally affected by chronic bronchitis. Exposure to biomass fuels for several hours every day & over several years in the domestic environment has been responsible for the additional burden of the disease in women⁶.

4. CANCER:

Studies have been conducted in China on the association between using coal as fuel & lung cancer⁴. Research pinpointed many chemicals such as the potent poly-aromatic hydrocarbons in biomass smoke, which are known to cause cancer in test animals in laboratories.

5. ADVERSE EFFECT ON PREGNANCY:

A 1991 study in Ahamedabad had shown that, women exposed to domestic smoke during pregnancy had 1.5 times the odds of stillbirth compared to mothers who are unexposed⁹.

Indirect evidence suggests that, increased carbon monoxide content, which occurs as a result of biomass burning, could lead to stillbirths, neonatal deaths or low birth weights.

APPROACH FOR SOLUTION OF THE PROBLEM:

Decreasing people's exposure to domestic pollution involves 3 types of improvement –

1. Improved ventilation:

Improved ventilation can solve the problem to some extent by

- bringing enough outdoor air to dilute emissions from indoor sources & .
- carrying indoor pollutants out of the home

2. Improved stoves:

Tests conducted within laboratory settings demonstrate that, improved chulhas can decrease the levels of pollutants emitted. A study comparing the minimum emission value of the traditional chulah with improved chulhas, reported 96% to 100% decrease in SO₂ levels. In addition, NO_x levels fell by 36% & 48% while HCHO levels decreased to 32% & 76% below the minimum emission values for a traditional stove^{10,11}.

3. Improved fuels:

Use of processed biofuels can solve the problem to a large extent. Biogas technology, if properly implemented, also has the potential to free people from the ill-effects of biomass-smokes.

Finally, unless & until the poverty can be alleviated in the rural sector, cleaner indoor environment cannot be achieved, rather it will deteriorate further.

II. INDOOR AIR QUALITY IN DEVELOPED COUNTRIES: (with special reference to USA)

The indoor air pollution of developed countries are quite different as compared to developing countries. In fact, there is no match between the two countries in this respect. The differences can easily be seen in the following illustrations.

1. Radon (Rn):

A. Sources:

- Earth & rock beneath home
- Well water
- Building materials

B. Health Effects:

Rn itself does not pose much of a danger to us because of its chemical inertness, physical state & low solubility in body fluids. The danger arises from the radioactivity arising from the 3 elements produced in sequence by the disintegration of Rn, namely, Po, Pb & Bi. In macroscopic amounts, these elements are solids & when formed in air they all quickly adhere to dust particles. Some dust particles adhere to lung surfaces. Both the ^{218}Po & ^{216}Po formed in sequence (image 1) emit energetic particles that can cause radiation damage to the bronchial cells near which the dust particles reside & eventually lead to lung cancer.

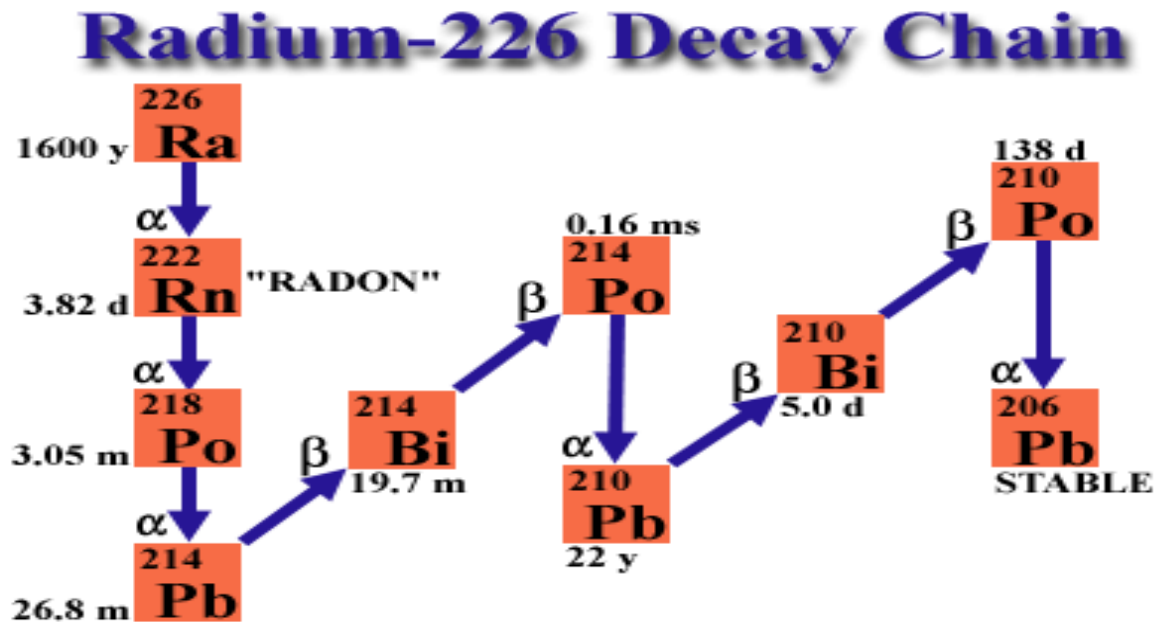


Image1. (Source: Internet)

[Ra- radium, Rn- radon, Po- polonium, Pb – lead, Bi- bismuth]

C. Steps to Reduce Exposure:

- The home must be tested for Rn. It's easy & inexpensive.
- The home must be fixed if Rn level found is 4 pCi/L or higher. Less than this value can still pose a risk & in many cases may be reduced.

2. Environmental Tobacco Smoke (ETS):

A. Sources:

Smokes from

- Cigarette
- Pipe &
- Cigar

B. Health Effects:

- Eye, nose & throat irritation
- Headaches
- Lung cancer
- Heart disease
- Specifically for children
 - increased risk of lower respiratory tract infections such as bronchitis & pneumonia.
 - ear infections, build up of fluid in the middle ear
 - increased severity & frequency of asthma episodes
 - decreased lung function

C. Steps to Reduce Exposure:

- Smoking must not be allowed in home specially when children are present.
- If smoking indoors cannot be avoided, ventilation must be increased by opening windows or by using exhaust fans in the area where smoking takes place.

3. Asbestos:

A. Sources:

- Asbestos is a mineral fibre that has been used commonly in a variety of building construction materials for insulation & as a fire-retardant. EPA & CPSC have banned several asbestos products.
- Today, asbestos is most commonly found in older homes in
 - pipe & furnace insulation materials,
 - asbestos shingles,
 - mailboard,
 - textured paints & other coating materials &
 - floor tiles.

B. Health Effects:

- Lung cancer
- Meso-thelioma (a cancer of the chest & abdominal linings)
- Asbestosis (irreversible lung scarring that can be fatal)

C. Steps to Reduce Exposure:

- It is best to leave undamaged asbestos material alone if it is not likely to be disturbed.
- Trained & qualified contractors must be used for control measures that may disturb asbestos & for cleanup.
- Proper procedures should be followed in replacing woodstove door gaskets that may contain asbestos.

4. Respirable Particles:

A. Sources:

- Fireplaces
- Woodstoves
- Kerosene heaters
- Environmental Tobacco Smoke (ETS)

B. Health Effects:

- Eye, nose & throat irritation
- Respiratory infections & bronchitis
- Lung cancer

C. Steps to Reduce Exposure

- All the furnaces must be vented outdoors.
- While using unvented space heaters, doors of the rest of house must be opened.
- Properly sized woodstoves with tightly fitting doors must be selected while purchasing.
- Filters on central heating and cooling systems & air cleaners must be changed according to manufacturer's directions.

5. Formaldehyde (HCHO):

A. Sources:

- Pressed wood products (hardwood plywood wall paneling, particle board, fireboard) & furniture made with these pressed wood products.
- Urea-formaldehyde foam insulation (UFFI)
- Combustion sources
- Environmental Tobacco smoke
- Durable press drapes, other textiles & glues

B. Health Effects:

- Can cause watery eyes
- Burning sensations in the eyes & throat
- Nausea
- Difficulty in breathing in some human exposed at elevated levels (above 0.1 ppm).
- High concentrations may trigger attacks in people with asthma.
- Cause cancer in animals & may cause cancer in humans.

C. Steps to Reduce Exposure:

- "Exterior-grade" pressed wood products to be used because they are lower- emitting as contain phenol resins, not urea resins)
- Air conditioner & dehumidifiers must be used to maintain moderate temperature & to maintain reduced humidity levels.

- Ventilation must be increased, particularly after bringing new sources of formaldehyde into the home.

6. Lead (Pb):

A) Sources:

- Lead-based paint
- Contaminated soil
- Dust &
- Drinking water

B) Health Effects:

- Lead affects practically all systems within the body.
- Lead at high levels (at or above 80 $\mu\text{g}/\text{dl}$ of blood can cause convulsions, coma & even death.
- Lower levels of lead can cause adverse health effects on the Central Nervous System (CNS), kidney & blood cells.
- Blood lead levels as low as 10 $\mu\text{g}/\text{dl}$ can impair mental & physical development.

C) Steps to Reduce Exposure:

- Areas where children play must be kept as dust-free & clean as possible.
- Lead based paint must be left undisturbed if it is in good condition & must not be burnt off.
- If someone's work or hobby involves lead, clothes must be changed & doormats must be used before entering home.
- Balanced diet rich in calcium & iron should be eaten.

7. Organic gases :

A. Sources:

- Paints
- Pain stripers & other solvents
- Wood preservatives
- Aerosol sprays
- Cleansers & disinfectants
- Moth repellants
- Air fresheners
- Stored fuels
- Dry-cleaned clothing

B. Health Effects:

- Eye, nose & throat irritation
- Headaches
- Loss of coordination
- Nausea
- Damage to liver, kidney & CNS

- Some organics can cause cancer in animals.
- Some are suspected or known to cause cancer in humans

C. Steps to Reduce Exposure:

- Household products must be used according to manufacture's directions.
- Proper ventilation must be maintained.
- Unused or little-used containers must be thrown away safely & must not be purchase in excess.
- These products must be kept out of children & pets.
- Household care products must not be mixed unless directed on the label.

8. Biological contaminants:

A. Sources:

- People, animal, soil & plant debris - sources of bacteria & viruses
- Household pets – sources of dander & cat saliva
- Rats & Mice - the protein in urine from rats & mice are sources of allergens
- House dust mites
- Cockroaches
- Plants - pollens originate from plants

B. Health Effects:

- Eye, nose & throat irritation
- Shortness of breath
- Dizziness
- Lethargy
- Fever
- Digestive problems
- Can cause asthma
- Influenza
- Other infectious disease

C. Steps to Reduce Exposure:

- Fans vented to outdoors must be used in kitchen & bathrooms
- Cloth driers must be vented to outdoors
- Ultrasonic humidifiers must be cleaned in accordance with manufacturer's instructions & must be refilled with clean water daily.
- Water trays in air conditioners, dehumidifiers & refrigerators must be emptied frequently
- Water-damaged carpet must be cleaned & dried or removed
- Basement areas can be used as living areas only if they are leak proof & have adequate ventilation. Use of dehumidifiers is necessary to maintain humidity between 30-50%.

9. Pesticides:

A. Sources:

- Products used to kill household pests (insecticides, termiticides & disinfectants)
- Products use on lawns & gardens that drift or are tracked inside the house.

B. Health Effects:

- Irritation to eye, nose & throat
- Damage to Central Nervous System & kidney
- Increased risk of cancer

C. Steps to Reduce Exposure:

- Pesticides must be used strictly according to manufacturer's directions
- Pesticides must be applied in recommended quantities
- Ventilation must be increased while using pesticide indoors
- Plants or pets must be taken outdoors when applying pesticides to them
- Non-chemical methods of pest control must be used where possible
- Pest control company must be selected carefully

In addition to abovementioned pollutants the problem of Carbon monoxide & Nitrogen dioxide also prevails to some extent which is similar in nature of developing countries. They are mentioned below.

1. Carbon monoxide (CO):

A. Sources:

- Unvented kerosene & Gas space heaters
- Leaking chimneys & furnaces
- Gas water heaters
- Woodstoves
- Fireplaces
- Gas stoves
- Automobile exhaust from attached garages
- Environmental Tobacco Smoke

B. Health Effects:

- At low concentrations, fatigue in healthy people & chest pain in people with heart disease
- At higher concentrations, impaired vision & co-ordination
- Headaches
- Dizziness
- Confusion
- Nausea
- Can cause flu-like symptoms that clean up after leaving home
- Fatal at very high concentrations

C. Steps to Reduce Exposure:

- The gas appliances must be kept properly adjusted
- Unvented space heaters must be replaced by a vented one
- Proper fuel must be used in kerosene space heaters
- Exhaust fan vented to outdoors over gas stoves must be used
- Flues must be kept open while fireplaces are in use
- Properly sized certified woodstoves with tightly fit doors should be used.
- Annual inspection, cleaning & tuning up of the central heating system of furnaces, flues & chimneys must be done by trained professional. Any leak must be repaired promptly
- The cars must not be kept idle inside the garage.

2. Nitrogen dioxide (NO₂):

A. Sources:

- Kerosene heaters
- Unvented heaters
- Unvented gas stoves
- Environmental Tobacco Smoke (ETS)

B. Health Effects:

- Eye, Nose & Throat irritation
- May cause impaired lung function &
- Increased respiratory infections in young children

C. Steps to Reduce Exposure:

Same as under carbon monoxide.

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