# AIR POLLUTION

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# GOLD COPD AIRPOLLUTION

### *Biomass exposure*

Tobacco smoking has been recognized as a major risk factor associated with COPD for over five decades, but this was largely because most research was conducted in high income countries. As more studies from LMICs were conducted,[19] it became apparent that non-smoking risk factors were more important in these parts of the world. Whilst tobacco smoking remains the leading risk factor for COPD in high income countries, accounting for over 70% of the cases, in LMICs tobacco smoking contributes to around 30% to 40% of the total burden.[9] Because the LMICs together contribute to over 85% of the total burden of COPD globally, non-smoking risk factors now contribute to over 50% of the global burden of COPD.[9]

Wood, animal dung, crop residues, and coal, typically burned in open fires or poorly functioning stoves, may lead to very high levels of household air pollution.[77] Household air pollution exposure is associated with an increased risk of developing COPD in LMICs[78] although the extent to which household air pollution versus other poverty-related exposures explain the association is unclear.[79-82] Almost three billion people worldwide use biomass and coal as their main source of energy for cooking, heating, and other household needs, so the population at risk worldwide is very large.[83,84] There is limited research about household air pollution related COPD or the interventions that could reduce the risk of developing it.[85]

## *Air pollution*

Air pollution typically consists of particulate matter (PM), ozone, oxides of nitrogen or sulfur, heavy metals, and other greenhouse gases, is a major worldwide cause of COPD, responsible for approximately 50% of the attributable risk for COPD in low and middle income countries (LMICs).[96] In never smokers, air pollution is the leading known risk factor for COPD.[97] The respiratory risk of air pollution to individuals is dose-dependent with no apparent "safe" thresholds. Even in countries with low ambient air pollution levels, chronic exposure to PM2.5 and nitrogen dioxides significantly impairs lung growth in children,[98] accelerates lung function decline in adults and increases the risk for COPD, especially among those with additional risk factors for COPD.[99] Poor air quality from air pollution also increases the risk of COPD exacerbations, hospitalizations and mortality.[100,101] Thus, reduction in both indoor and outdoor air pollution is a key goal in the prevention and management of COPD.


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# Acute effects of ambient air pollution exposure on lung function in the elderly in Hangzhou, China

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# Association between air pollution and lung function change

- percentage changes in lung function per 10 μg/m3 increase in a single pollutants with moving day average exposure.
- PM2.5, PM10, and NO2 were significantly associated with  a decreased FEV1.
- PM2.5 PM10, NO2, and SO2 were significantly associated with a decreased FVC.
- PM2.5 and NO2 were significantly associated with decreased FEF25%–75%.

- We found that short-term exposure to ambient air pollutants was associated with decreased lung function parameters (FEV1, FVC, and FEF25%–75%).

We found that PM2.5 exposure was significantly associated with a decrease in FEF25%–75% for up to 7 days, indicating that PM2.5 has a greater impact on small airway lung function (FEF25%–75%) than on big airway lung function (FEV1 and FVC). Evidence suggests that PM2.5 can produce inflammatory cells and inflammatory mediators, including cytokines, chemokine's, and adhesion molecules, which can lead to reduced small airway lung function.

# Conclusions

- In conclusion, we found that short-term ambient air pollutant exposure was associated with decreased lung function parameters among healthy elderly individuals.
- Gaseous pollutants not only affect lung function but also enhance the association between PM pollutants and lung function parameters.
- women were more susceptible to air pollutants.
- These results emphasize that the elderly population, especially females, should be aware of the dangers of air pollutants. Protective measures are required for exposure to ambient air pollutants for one week.

Clinical reviews in allergy and immunology

# Air pollution and lung function in children



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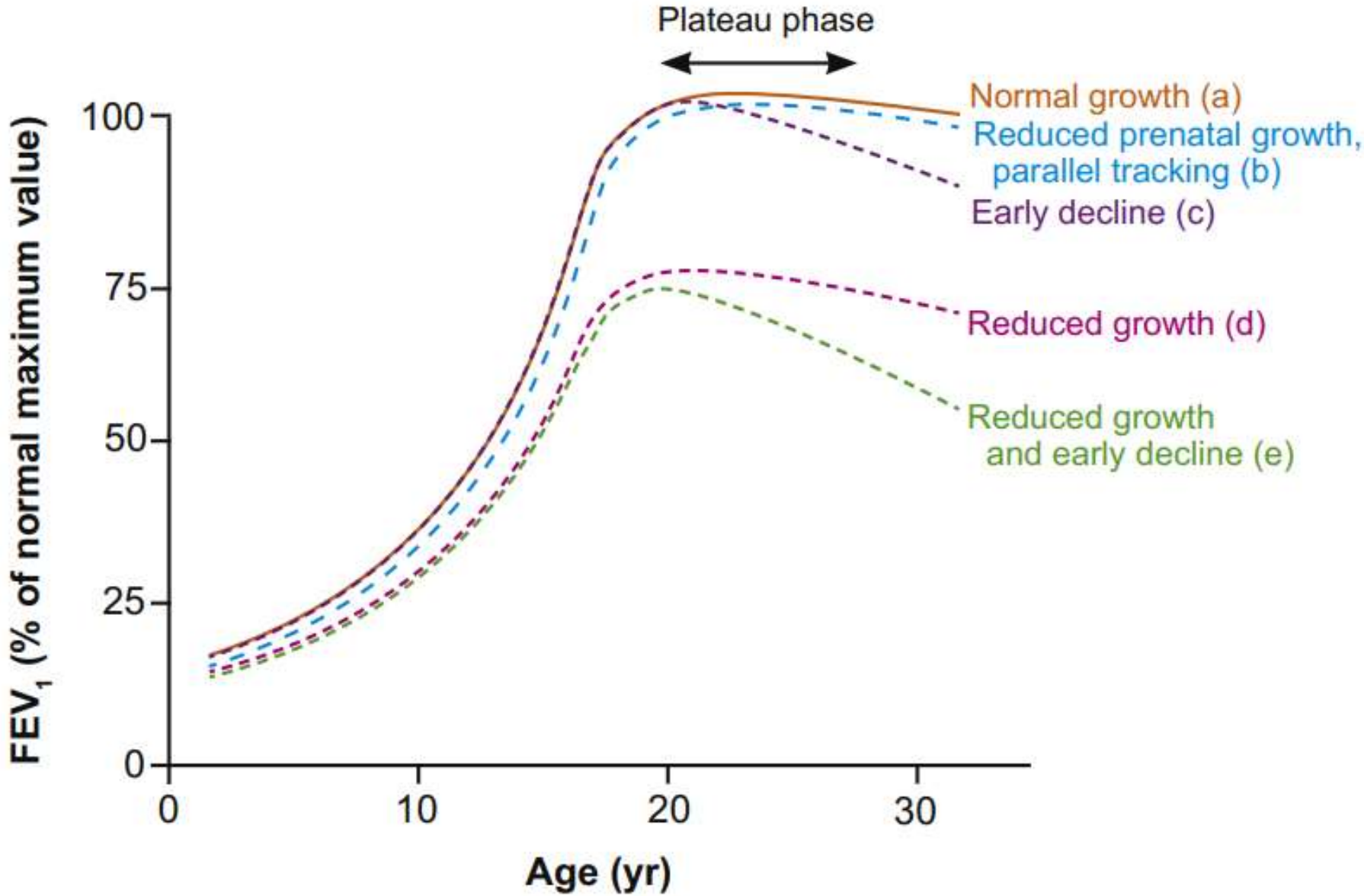
Plateau phase
Normal growth (a)
Reduced prenatal growth, parallel tracking (b)
Early decline (c)
Reduced growth (d)
Reduced growth and early decline (e)
100
75
50
25
0
0
10
20
30
FEV1 (% of normal maximum value)
Age (yr)

# SHORT-TERM AMBIENT AIR POLLUTION EXPOSURE AND CHILD LUNG FUNCTION

Higher O3 exposure has been linked with lower levels of lung function (both FEV1 and FVC) in healthy children and those with asthma.

Short-term PM2.5 exposure has been associated with acute decrements in lung function, including lower FEV1/FVC, in healthy pediatric populations.

Short-term PM10 exposure has also been linked with acute lung function decrements in children.

- wildfires are occurring at increasing frequency and are a major source of PM and other pollutants  PM2.5 levels during wildfires can reach extreme concentrations that far exceed air quality standards and are associated with acute decrements in peak expiratory flow.
- short-term elevations in NO2 levels outdoors and indoors have been associated with reduction in child lung function.

# LONG-TERM AMBIENT AIR POLLUTION EXPOSURE AND CHILD LUNG FUNCTION

Schultz et al concluded that regardless of the timing of exposure, early-life and school-age exposure to traffic-related air pollution adversely affects children's lung function.

## Summary observations

- A large number of studies support a relation between early-life or long-term air pollution exposures and subsequent children's lung function level, with the most epidemiologic evidence for PM2.5 and NO2
- Associations with long-term exposures are more consistent for FEV1 compared with for FVC, which may indicate greater impacts on airway caliber/airflow obstruction than overall lung size or growth.

# INDOOR SOURCES OF AIR POLLUTION AND CHILD LUNG FUNCTION

**Indoor biomass and coal burning**
studies of indoor biomass or coal burning for cooking or heating have generally found that these exposures are associated with lower lung function in children.

The largest of these followed more than 3000 children aged 6 to 13 years with repeated lung function measures in 4 Chinese cities and found that use of coal as a household fuel was associated with a 16.5 mL/y lower annual growth of FEV1 and a 20.5 mL/y lower growth of FVC.

This study also found that household ventilation improved lung function growth.

Indoor biomass burning is a phenomenon not only in low- and middle-income countries. Wood-burning stoves are a common source of heating in many high-income countries. In the United States, wood stove use has been increasing over the past 2 decades, and it has been estimated that 11 million households and more than 3 million children are exposed to higher levels of indoor particulate matter due to the use of wood-burning stoves for heating .

## What do we know?

- Short-term exposure to ozone, nitrogen dioxide, and particle pollution has been associated with lower child lung function
- Fine particulate matter levels can reach extreme concentrations during wildfires, and are associated with acute decrements in peak expiratory flow
- Long-term early childhood exposure to ambient pollutants, especially nitrogen dioxide and fine particulate matter, is associated with subsequent children's lung function level
- Children worldwide are often highly exposed to smoky household air pollution at a very critical age of lung development

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# Association of Improved Air Quality with Lung Development in Children

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# METHODS

As part of the Children's Health Study, we measured lung function annually in 2120 children from three separate cohorts corresponding to three separate calendar periods: 1994–1998, 1997–2001, and 2007–2011.

Mean ages of the children within each cohort were 11 years at the beginning of the period and 15 years at the end.

## RESULTS

improvements in 4-year growth of both FEV 1 and FVC were associated with declining levels of nitrogen dioxide
and of particulate matter .

Significant improvements in lung-function development were observed in both boys and girls and in children with asthma and children without asthma. The proportions of children with clinically low FEV1 (defined as <80% of the predicted value) at 15 years of age declined significantly, from 7.9% to 6.3% to 3.6% across the three periods, as the air quality improved (P=0.001)

Review Article on Pollutional Haze

# Air pollution and chronic airway diseases: what should people know and do?

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air pollution was associated with many respiratory diseases.

The detrimental effects include decrease in pulmonary function, increase of infections, increase in respiratory symptoms, acute exacerbations of COPD, onset of asthma, more hospitalizations, increased respiratory mortality.

**Table 2** Adverse respiratory health effects (22)

| |
|---|
| Increased mortality |
| Increased incidence of cancer |
| Increased frequency of symptomatic asthmatic attacks |
| Increased incidence of lower respiratory tract infections |
| Increased exacerbations of chronic cardiopulmonary or other disease |
| Reduction in $FEV_1$ or FVC associated with clinical symptoms |
| Increased prevalence of wheezing |
| Increased prevalence or incidence of chest tightness |
| Increased prevalence or incidence of cough/phlegm production requiring medical attention |
| Increased incidence of acute upper respiratory infections that interfere with normal activity |
| Acute upper respiratory tract infections that do not interfere with normal activity |
| Eye, nose, and throat irritation that may interfere with normal activity |
| Odors |

Research indicated that traffic-related  air pollution exposure during infancy was associated with decreased lung function, and long-term respiratory consequences in susceptible children.

# Measures against ambient air pollution

- Regulate daily activity according to the air quality index (AQI)
- Use of masks

- Surgical face mask and plain face mask are designed for preventing and avoiding spillage droplets spread and large particulate materials usually hundred micrometer large. But they are not of any use in preventing inhalation of fine articles like PM2.5.
- N95 and R95 face mask is a kind of efficient filter masks which can absorb as high as 95% of airborne particles in the inhaled air. The later type is more efficient and should be recommended as efficient protective measure in minimizing exposure to gas emissions.

# Measures for indoor air pollution

To choose furniture with less chemical emission,

check the ventilation system of the house regularly,

ventilate the room as opening the door and windows regularly to fresh the air so as to reduce harmful gaseous pollutants from the furniture and construction material,

use clean fuels instead of biomass fuels if possible,

improve cooking stoves to burn fuel more efficiently and use a chimney woodstove to vent emissions to outside.

Particle filtration systems can supply filtered air into the room or whole-house, reducing indoor exposures to particles from outdoor air and reduce the morbidity and mortality associated with air particles.

using indoor air cleaning devices can significantly

reduce indoor PM concentrations,

improve air quality

increase symptom-free days,

reduce asthma trigger and

improve health outcomes.

improve bronchial hyper responsiveness in asthma children

reduce asthma morbidity by filtrating particle and adsorbing gaseous pollutants.

The basic mechanism of air cleaner is air filtration by which airborne pathogens were reduced and spread of airborne infectious diseases was prevented.

Most air cleaners have HEPA filter, which is highly efficient in PM filtration.

Air cleaners with electrostatic generator can also considerably reduce particle concentration in indoor air. Other units include UVGI lights, ions generator, and activated carbon.

# Association Between Long-term Exposure to Ambient Air Pollution and Change in Quantitatively Assessed Emphysema and Lung Function

Meng Wang, PhD; Carrie Pistenmaa Aaron, MD; Jaime Madrigano, ScD; et al

JAMA. 2019;322(6):546-556.

Studies conducted in 6 metropolitan regions of the United States, which included 6814 adults aged 45 to 84 years recruited between July 2000 and August 2002, and an additional 257 participants recruited from February 2005 to May 2007, with follow-up through November 2018.

Ambient concentrations of $O_3$, $PM_{2.5}$, $NO_x$, and black carbon at study baseline were significantly associated with greater increases in percent emphysema per 10 years.

Ambient $O_3$ and $NO_x$ concentrations, but not $PM_{2.5}$ concentrations, during follow-up were also significantly associated with greater increases in percent emphysema.

Ambient $O_3$ concentrations, but not other pollutants, at baseline and during follow-up were significantly associated with a greater decline in forced expiratory volume in 1 second per 10 years.

## Conclusions and Relevance

In this cohort study conducted between 2000 and 2018 in 6 US metropolitan regions, long-term exposure to ambient air pollutants was significantly associated with increasing emphysema assessed quantitatively using CT imaging and lung function.

# Air pollution, lung function and COPD: results from the population-based UK Biobank study

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Eur Respir J 2019; 54: 1802140

We used UK Biobank data on 303 887 individuals aged 40–69 years.

Higher exposures to each pollutant were significantly associated with lower lung function.

A 5 μg·m-3 increase in PM2.5 concentration was associated with lower FEV1 and FVC.

COPD prevalence was associated with higher concentrations of PM2.5, PM10 and NO2, but not with PMcoarse.

Stronger lung function associations were seen for males, individuals from lower income households, and “at-risk” occupations, and higher COPD associations were seen for obese, lower income, and non-asthmatic participants.
Ambient air pollution was associated with lower lung function and increased COPD prevalence in this large study.

# Air pollution exposure and lung function until age 16 years: the PIAMA birth cohort study

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Eur Respir J 2018; 52: 1800218

We conducted both longitudinal (n=915) and cross-sectional (n=721) analyses of associations of air pollution exposure with forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC) growth from ages eight to 16 and FEV1 and FVC at age 16.

Higher air pollution exposure was associated with reduced FEV1 growth and lower, but was not adversely associated with FVC. Associations with FEV1 were stronger in boys than girls and were not modified by asthma status. Higher air pollution exposure may lead to increased airway obstruction, but not reduced lung volume in adolescence.

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# Comparison of Pulmonary Function Test in School - Age Children in Clean and Polluted Air in Tehran, Iran

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## Abstract

**Background:** Children seem to be more susceptible to deleterious effects of air pollution related to respiratory functional parameters as compared to adults and thus quite perceptively assessment of these pathological changes among children is necessary. The present study aimed to assess the effects of air pollution on respiratory functional parameters among primary school children in Tehran, Iran.

**Methods:** This cross - sectional survey was performed on 102 children aged less than 12 years studying at a primary school in Tehran in 2015. At two time points with healthy and unhealthy air conditions (December 2015 and May 2016), all eligible children were evaluated with respect to respiratory functional parameters (FEV1, FEV1/FVC, FVC, PEF, FEF25 - 75) using a spirometer.

**Results:** There were significant differences in respiratory some parameters including FEV1 (P = 0.013) and PEF (P = 0.003) between the two times of respiratory assessment, no difference was found in some others such as FVC, FEV1/FVC and FEF25 - 75.

**Conclusions:** Air pollution can be harmful for respiratory functional status in children by reducing FEV1 and PEF parameters.

*Keywords:* Spirometry, FEV1, PEF, Air Pollution, Pollutants