



HEALTH PROFESSIONALS FOR CLEAN AIR

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LATEST RESEARCH

AIR POLLUTION IMPACTS ON CHILDREN



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Resources

ALA State of the Air Report and National Summaries on Air Pollution

NIEHS/EPA Centers for Children's Environmental Health-

<https://www.niehs.nih.gov/research/supported/centers/prevention/index.cfm>

Environmental Health Perspectives "Children's Health Collection"

<http://ehp.niehs.nih.gov/childrens-health/>

NEW UC Davis Environmental Health Sciences Center

<https://ehscc.ucdavis.edu/>

Part of a national program of NIEHS funded EHS CC:

<http://www.niehs.nih.gov/research/supported/centers/core/>

Review article of So Cal Children's Health Study:

Chen et al J Thoracic Dis 2015

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NIH National Institute of Environmental Health Sciences
Your Environment. Your Health.

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NIEHS/EPA Children's Environmental Health and Disease Prevention Research Centers

Program Description
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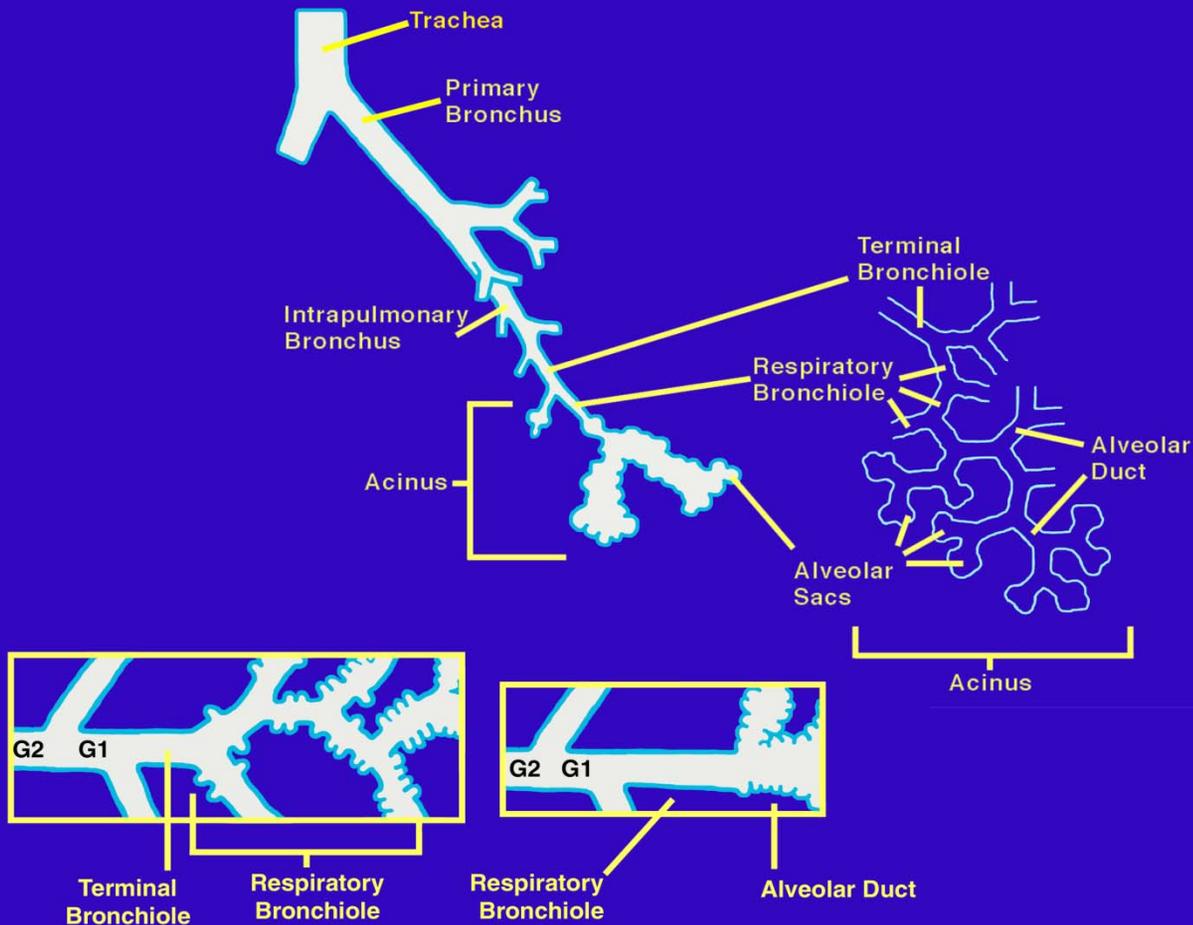
Community Partners News
A Twitter list by @UCDavisEHSC

Children are a uniquely susceptible population for adverse health outcomes from air pollution exposures

due to

postnatal development of many organs,
high potential for outdoor exposures,
small body size

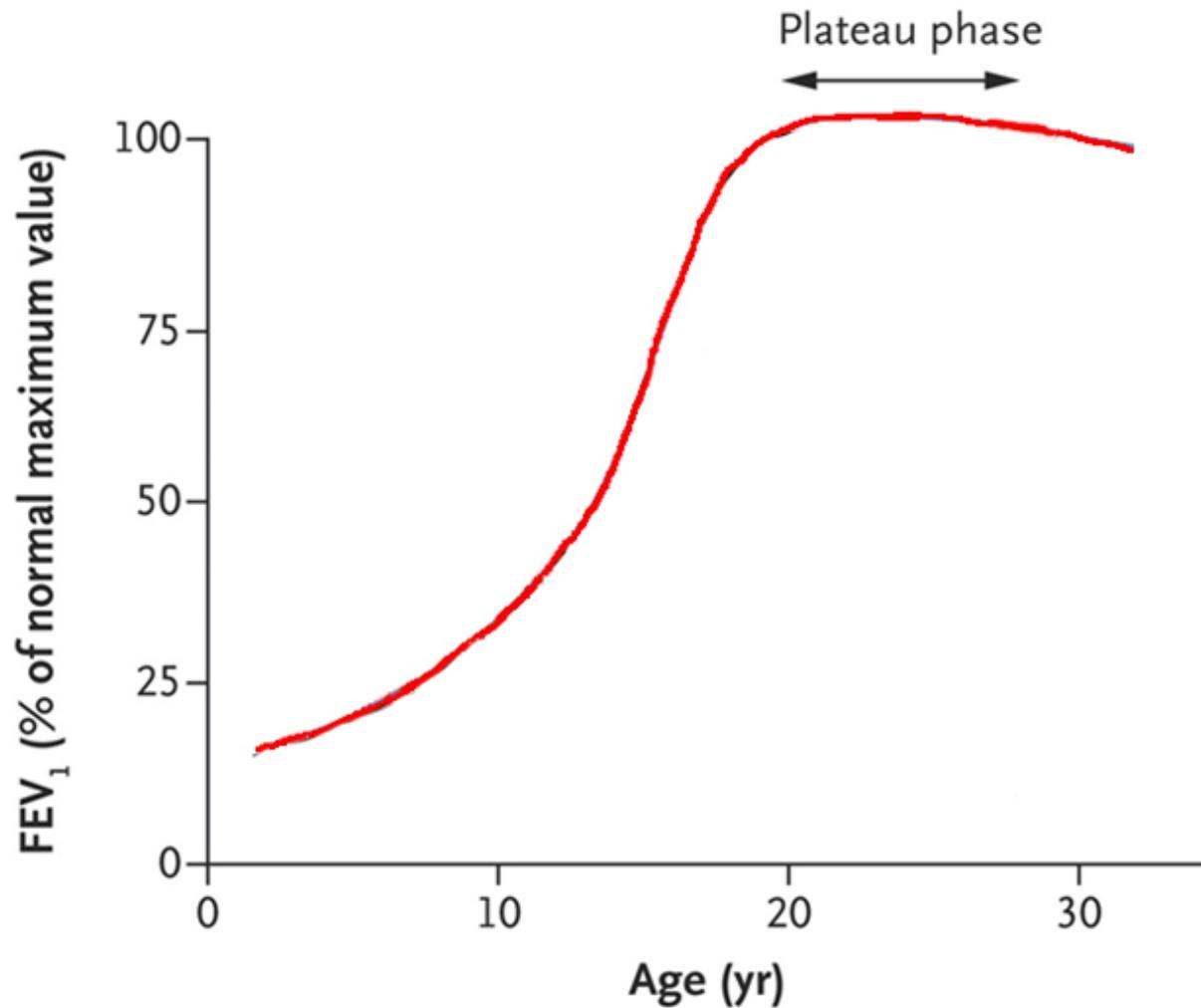
Lung Growth and Development Targets for Effects



The lung is not fully formed at birth and during the postnatal period many cells are still differentiating while the lung is also growing.

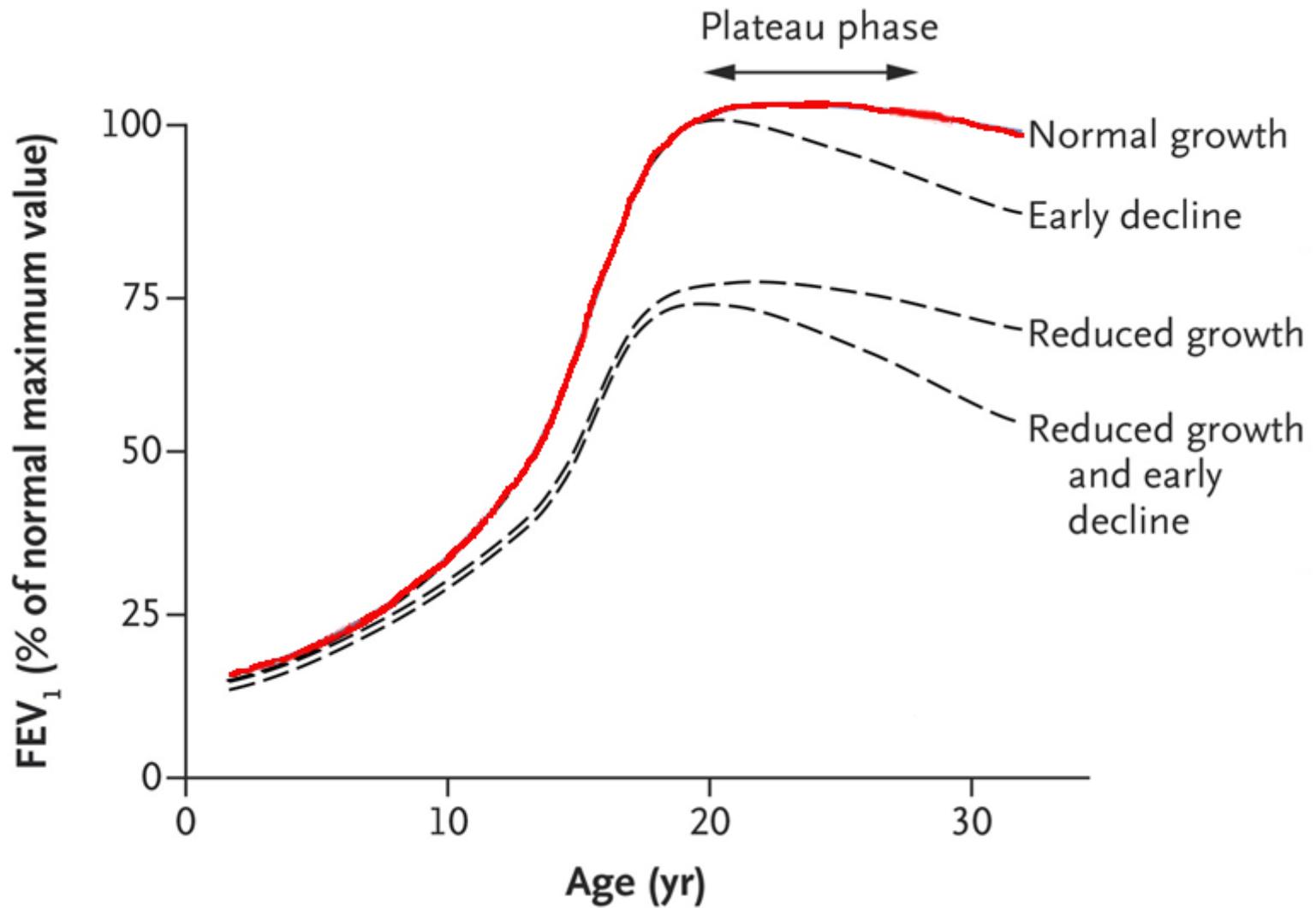
Maturation of conducting airway epithelium occurs in a proximal to distal direction

Longitudinal Normal Lung-Function Trajectory



Modified from McGeachie MJ et al. N Engl J Med 2016;374:1842-1852 figure adapted from Speizer and Tager.

Longitudinal Lung-Function Trajectories



Modified from McGeachie MJ et al. N Engl J Med 2016;374:1842-1852 figure adapted from Speizer and Tager.

Ozone Effects in the Healthy Lung?

Animal Studies have shown:

Episodic exposures having larger long term effects on lung remodeling than chronic exposures or single acute exposures. Younger animals are more susceptible. Barr et al TAP 1990. Fanucchi et al AJP: Lung 2006

Ozone exposure at moderate or high levels causes direct cellular damage to lung epithelium and inflammation. Episodic exposures cause oxidant stress, inflammation and altered neurokinin responses. Pino et al TAP 1992. Murphy et al AJRCMB 2012. Murphy et al Tox Sciences 2013

Early postnatal, adolescent and young adult animals are more susceptible (than adult or aged animals) to ozone induced changes in ventilation and pulmonary injury/inflammation. Snow et al Inhalation Toxicology 2016

Episodic ozone exposure enhances allergic sensitization and addition of an allergen exposure to an ozone exposure results in greater airway remodeling and reactivity. Schelegle et al TAP 2003

Ozone Effects in the Healthy Lung?

Epidemiologic studies have shown decreased lung function and possible increases in asthma incidence:

Chronic exposure to ozone results in decreased lung function in young adults, and an effect on small airways is implicated. Tager et al Epidemiology 2005

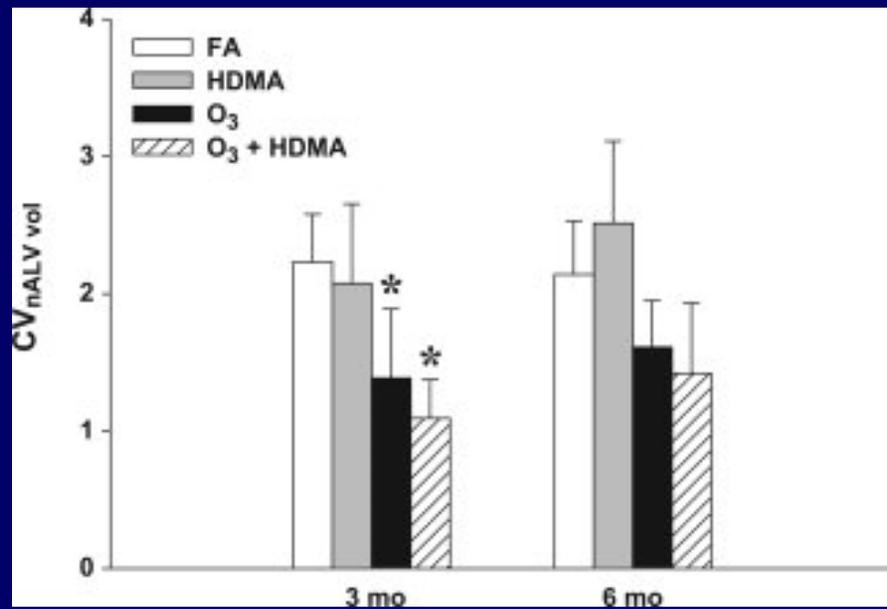
This change can take place early in life: Schoolchildren in Mexico City (8yrs) have a deficit in lung function that correlates with ozone exposure (also PM). Rojas-Martinez et al AJRCCM 2007

Children who exercise outdoors in a high ozone environment can have an increased incidence of new diagnoses of asthma. McConnell et al Lancet 2002

Early life ozone exposure was associated with increased asthma without detectable allergic sensitization in a Latino population of asthmatic children aged 8-21. Nishimura et al JACI 2016

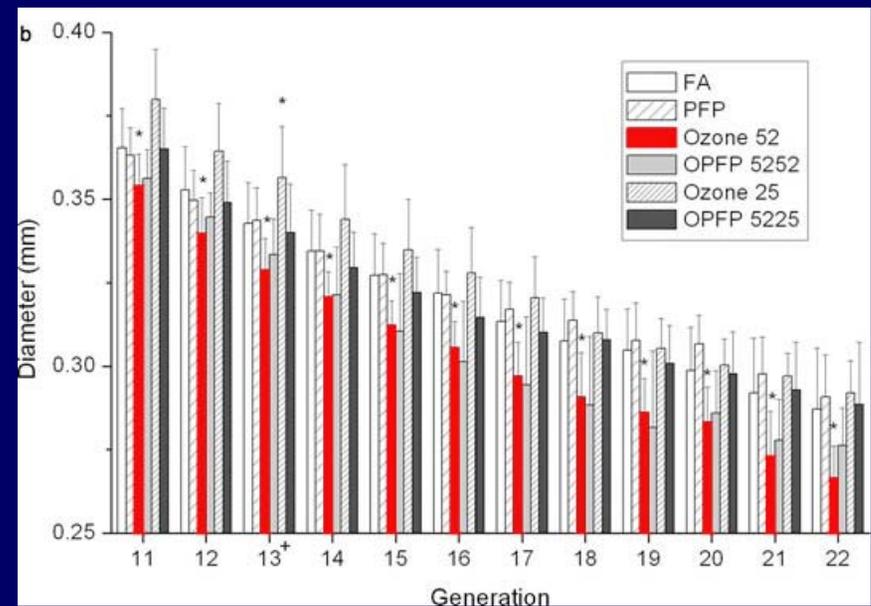
Episodic Ozone Exposure Alters both Alveolar Growth and Airway Growth in Animal Models

Ozone and Alveolar Growth



Avdalovic et al 2012 Anat Rec
295(10):1707-16

Ozone and Airway Growth



Lee et al 2011 Inhalation Toxicology
23(9):520-31

Ozone effects during lung development?

Ozone exposure during lung development causes airway, immune system and parenchymal remodeling changing lung function in humans and possibly predisposing to asthma

BUT the mechanisms involved and the interaction of these effects with other co-pollutants, such as PM and near roadway vehicle exhaust, is a very active area of current research.

Fetal Effects of Air Pollution

Pre-term Birth/Low Birth Weight

A California statewide nested case–control study population from 2001-2008 and exposures to both primary (PM_{2.5} and ultrafine particles from traffic sources) and secondary (ozone, nitrate, ammonium and SOA) pollutants were associated with an increase in pre-term birth. Near roadway traffic related exposures had the strongest associations. Laurent et al, EHP 2016

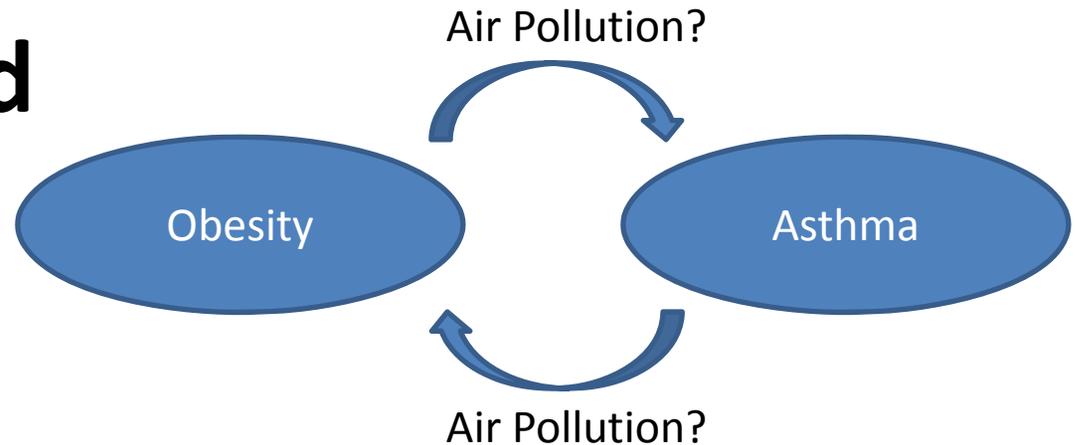
The time-stratified case-crossover design in Brisbane Australia found that high levels of hourly ambient air pollution in the preceding 24 or 48 hrs prior to birth (NO₂, SO₂, CO in the 95th percentile) increased OR for preterm birth. BUT Ozone and PM were not found to have an effect. Li et al EHP 2015

Decreased air pollution in Beijing China associated with the Olympics resulted in higher birthweights. Rich et al EHP 2015

How?

Many emerging epidemiologic and animal model studies implicate effects of air pollution (particles, diesel, urban ambient) on the placenta Van den Hooven et al EHP 2012; Hettfleisch et al EHP 2016; Saenen et al Am J Epidemiol 2016; Saenen et al EHP 2016; Valentino et al Part Fibre Tox 2016; Veras et al Biol Reprod 2008; Rocha et al Fertil Steril 2008;

Air Pollution and Obesity



Epidemiologic Studies

Traffic within 150m of a child's home had a significant positive association with BMI at age 18. Longitudinal cohort was of children 10-18 years old and was based in Southern CA. Jerrett et al Prev Med 2010

Traffic pollution was positively associated with growth in BMI in S CA children aged 5-11. Jerrett et al Env Health 2014

Mexico City normal weight school children exposed to high levels of PM2.5 and ozone have fasting hyperleptinemia and altered appetite-regulating peptides. These changes could signal the future trajectory of urban children towards the development of insulin resistance, obesity, type II diabetes. Calderón-Garcidueñas et al Env Research 2015.

Animal Models:

Rats with a sedentary lifestyle had an increase in ozone induced eosinophilia (inflammation that has been related to asthma) that was reduced by activity. Gordon et al AJP: Lung 2016

Near Roadway Vehicle Exhaust



Vapors and particles (PM)
Also roadway dusts

Proximity to a major roadway/traffic pollution is associated with

- **Increased asthma** with closer residential distance to a freeway and also exposure to outdoor freeway air pollution Gauderman et al Epidemiology 2005
- substantial **deficits in lung function** at age 18 in children who live within 500m of a major freeway. Gauderman et al N Engl J of Med 2005. Gauderman et al Lancet 2007
- **Asthma exacerbations** was associated with air pollution exposure and the association was stronger among individuals who lived with higher levels of traffic related air pollution. Delfino et al Epidemiology 2014
- **Increased exhaled NO** in breath, indicative of distal airway effects and **inflammation** Eckel et al Eur Resp J 2016

Traffic related air pollution exacerbates upper and lower **respiratory infections** (based on ED visits). Darrow et al Am J Epidemiol. 2014

Ongoing studies are investigating the causative agents in near roadway pollution (including PAH components) and the critical windows of exposure that result in susceptibility to lung health effects.

Air Pollution affects more than the respiratory tract- Brain health

PM2.5 from traffic associated with **reduction in cognitive development**.

Basagana et al EHP 2016

Exposure to TRAP, NO₂, PM_{2.5} and PM₁₀ during pregnancy and the first year of life was associated with **autism**. Volk et al JAMA Psychiatry 2013. Volk et al EHP 2011

Prenatal air pollution exposure associated with **autism**. 7000 + children of mothers who gave birth in LA. Ozone and PM_{2.5} associated with 12-15% increased risk and NO₂/NO risk was an increase of 3-9% per IQR increase.

Becerra et al EHP 2016

Childhood exposure to traffic-related pollution may adversely affect **executive function development**. Harris et al Neurotox and Teratology 2016

Thanks!

Acknowledgements:



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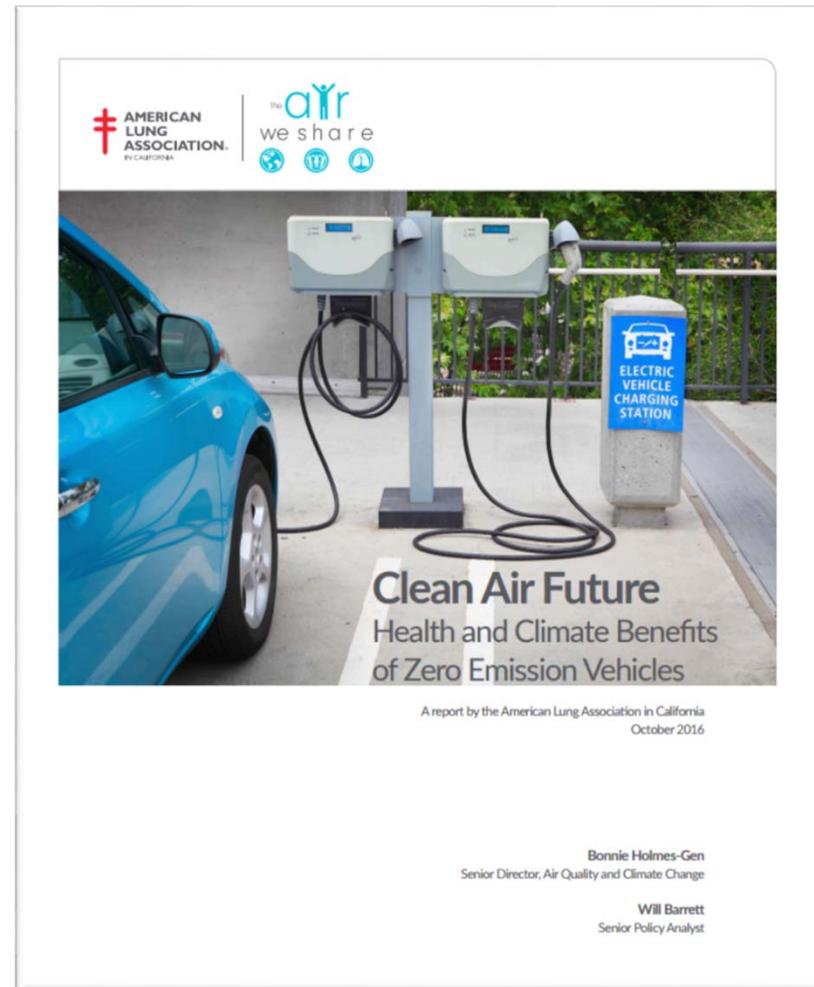
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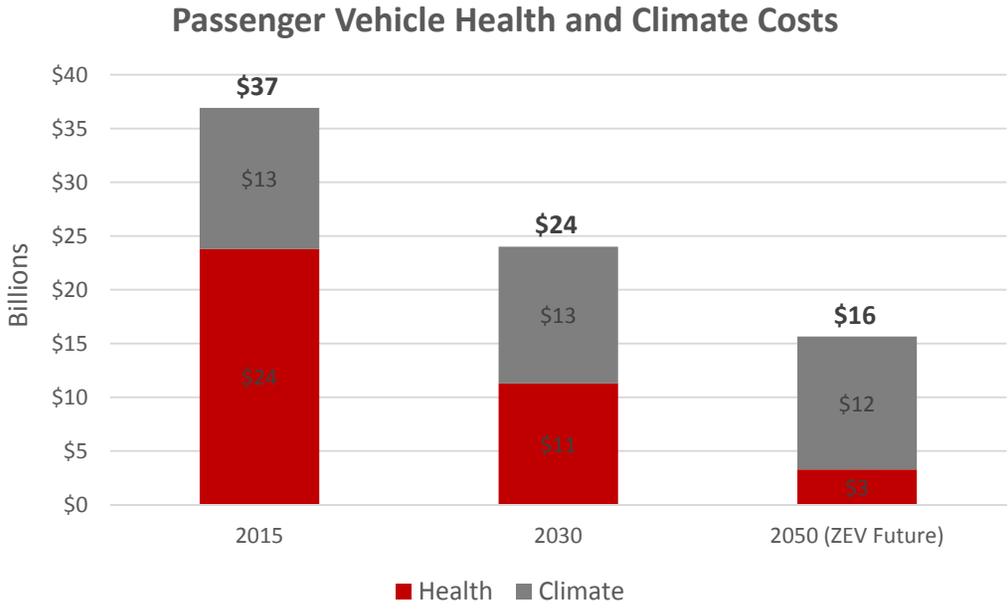
CLEAN AIR FUTURE

HEALTH AND CLIMATE BENEFITS OF ZERO EMISSION VEHICLES



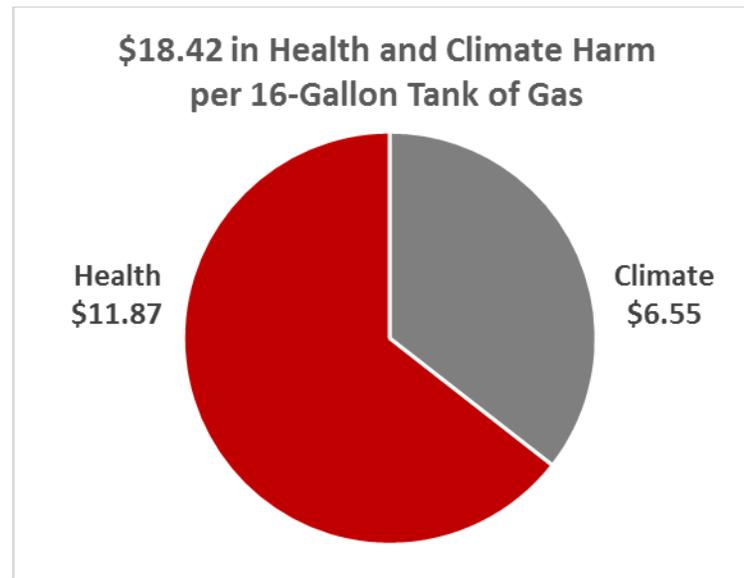
WHAT DOES PASSENGER VEHICLE POLLUTION COST US?

TENS OF BILLIONS IN HEALTH AND CLIMATE IMPACTS



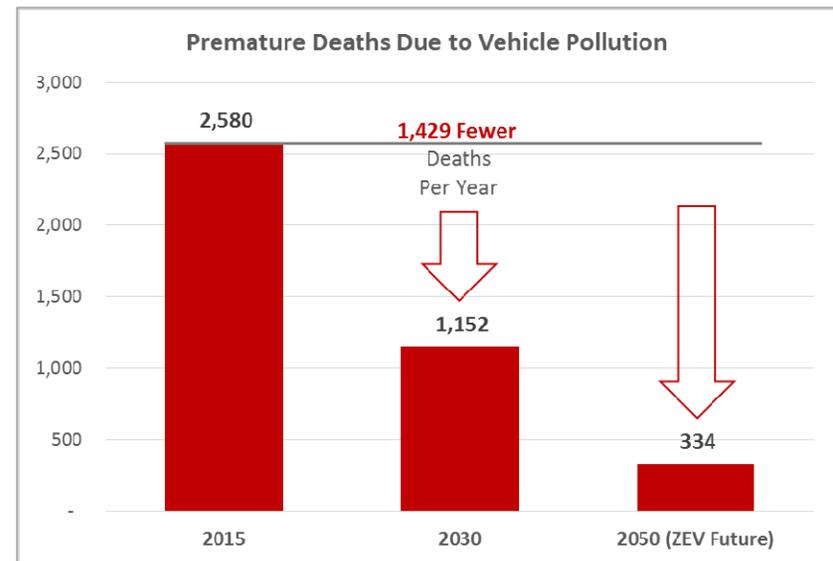
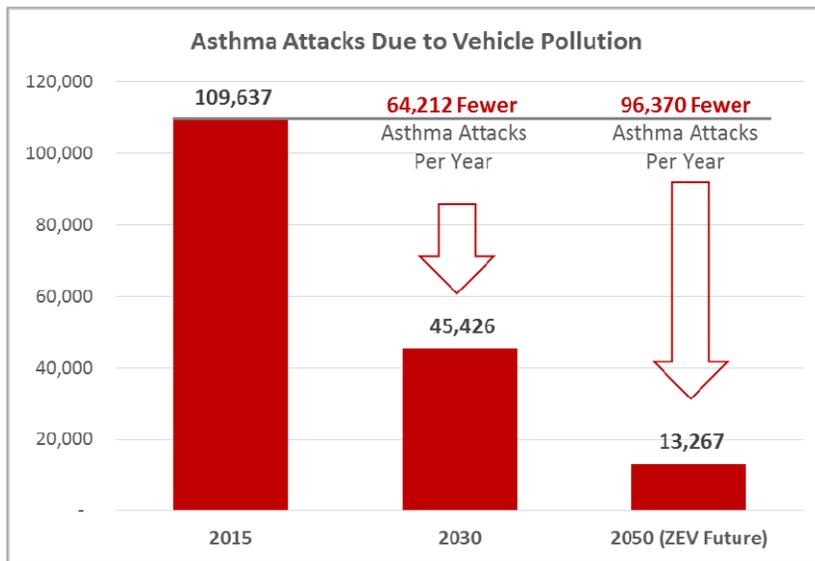
WHAT DO WE CONTRIBUTE?

EVERYDAY COSTS OF COMBUSTION VEHICLES



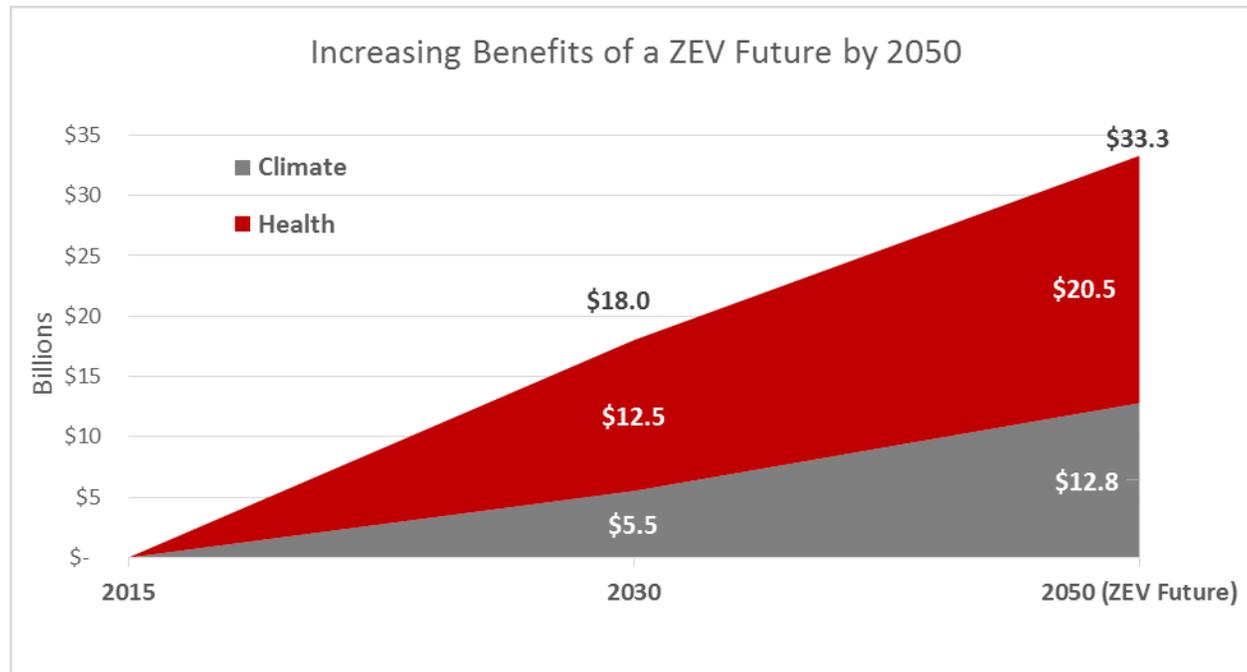
THE HEALTH BENEFITS OF ZEVS?

MORE ZEVS = GREATER HEALTH AND CLIMATE BENEFITS



THE HEALTH BENEFITS OF ZEVS?

MORE ZEVS = GREATER HEALTH AND CLIMATE BENEFITS



NEXT STEPS

AIR RESOURCES BOARD

- **December 2016** staff report on implementation of vehicle standards
 - Zero Emission Vehicle Standards
 - Greenhouse Gas “*Pavley*” Standards
 - Particle Pollution Standards
- **February 2017** Board Hearing on Mid-Term Review, followed by:
 - Potential for updates to 2025 standards
 - Planning for post-2025 standards



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A LIFETIME OF CLEAN AIR ACHIEVEMENTS





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