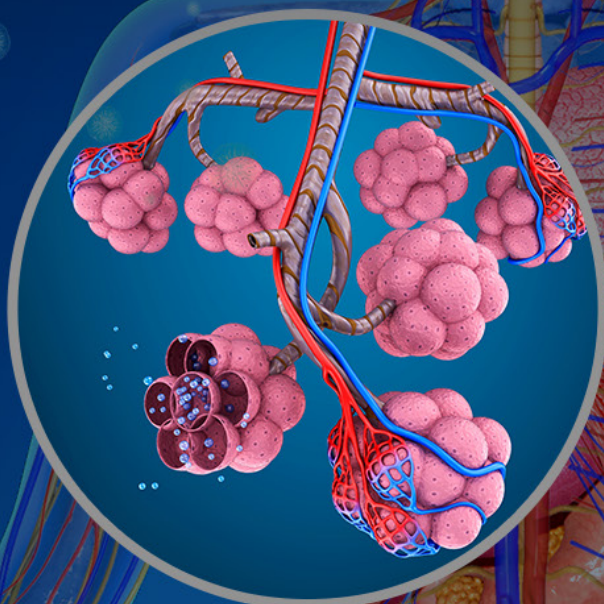


White Paper: Allergy & Asthma – The Impact of Ultrafine Particles



Allergy and Asthma

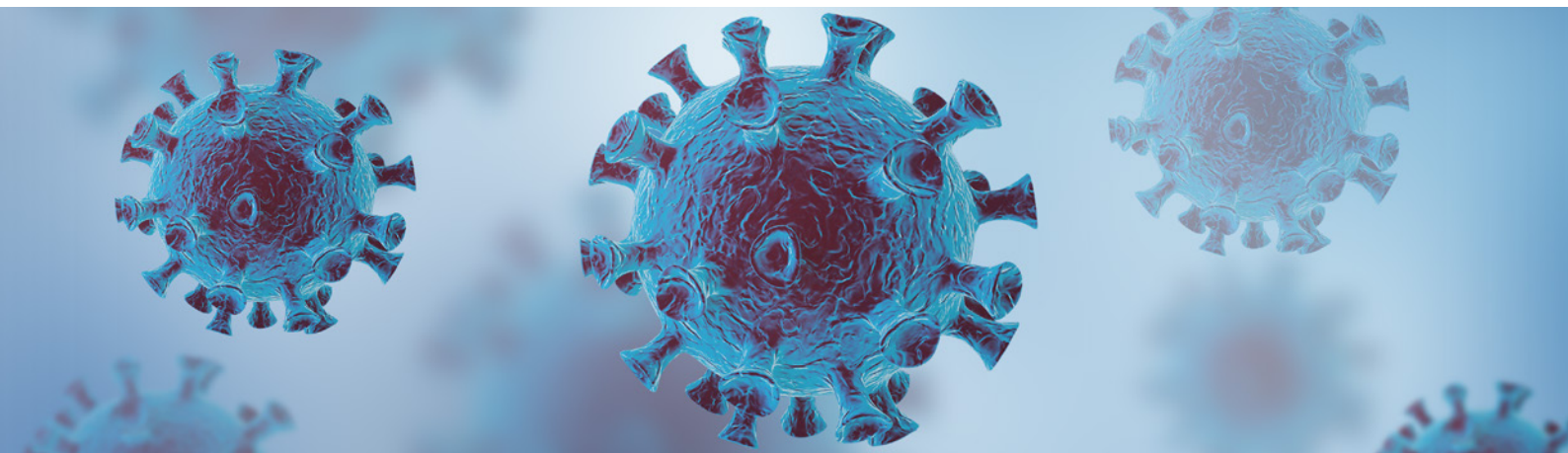
Globally, 12-40% of us suffer from allergic rhinitis⁴ or hay fever. We have also seen allergy seasons throughout the world have been getting longer since the early 1980s⁴ so more people suffer longer each year as pollen, one of the biggest allergy triggers, stays around longer. Allergy triggers are also what trigger episodes of asthma. Globally, more than 330 million people suffer from asthma²⁰ and that number too continues to grow in all regions³. Allergy and Asthma triggers include:

- Pollens
- Molds
- Dust mite & cockroach allergens
- Animal hair, dander, saliva, urine
- Tobacco smoke
- VOCs, fumes, vapors or odors (such as paint, gasoline, perfumes and scented soaps and Vape cigarette emissions)
- Air pollution
- Smoke from wood or charcoal
- Dust and particles in the air

These triggers are airborne particles that cause respiratory system inflammation. For people with severe asthma, that can lead to hospitalization or death. But, it is not just health issues that impact people, there are financial costs as well. In 2018, asthma sufferers in the USA spent an average of \$3,266 on medical treatment for their asthma²³ and that doesn't even include over-the-counter remedies and non-medical expenses. In the USA, Allergy sufferers spend more than \$20 billion a year just for medical costs and the total cost of allergies to the American economy each year is estimated at around \$80 billion.

To reduce allergy and asthma symptoms, doctors and other medical professionals recommend removing as many of triggers from the air as possible. Inexpensive HEPA filters can remove the larger particles from the air, for example, intact pollen because most pollens are very large. Because of its size, pollen usually only penetrates as far as the nose and upper throat before the body stops it. However, subpollen particles² (pieces of broken pollen that still contain allergy triggers) can penetrate deep into the lungs where they can cause significant inflammation of those airways.

Most air purifier filters, including HEPA filters, are not designed to remove extremely small particles such as ultrafine particles that are smaller than 0.1microns. Research shows that ultrafine particles are especially dangerous to people with allergies and asthma. This article addresses how ultrafine particles impact people who suffer from allergies and asthma.

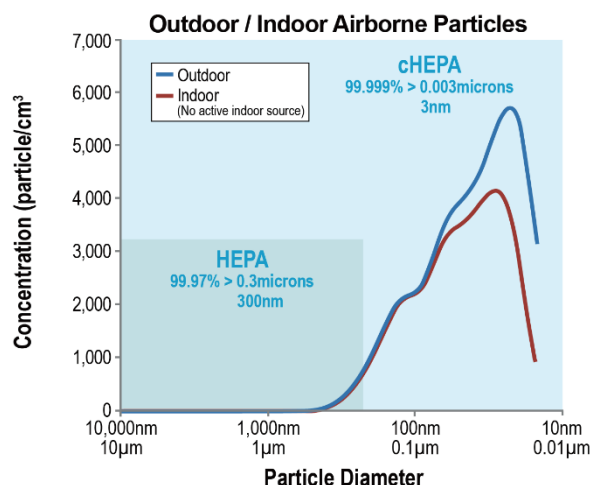


Ultrafine Particles

Ultrafine particles are smaller than 0.1microns and they are especially dangerous to people with allergies and asthma. Just like the commonly known triggers listed above, ultrafine particles can generate both primary and secondary allergic responses¹². Additionally, ultrafine particles can cause more severe responses and sensitivities to other allergic triggers¹⁹. This increased sensitivity to allergy triggers was seen up to 4 days¹ and, in another study, even 28 days¹¹ after exposure to ultrafine particles.

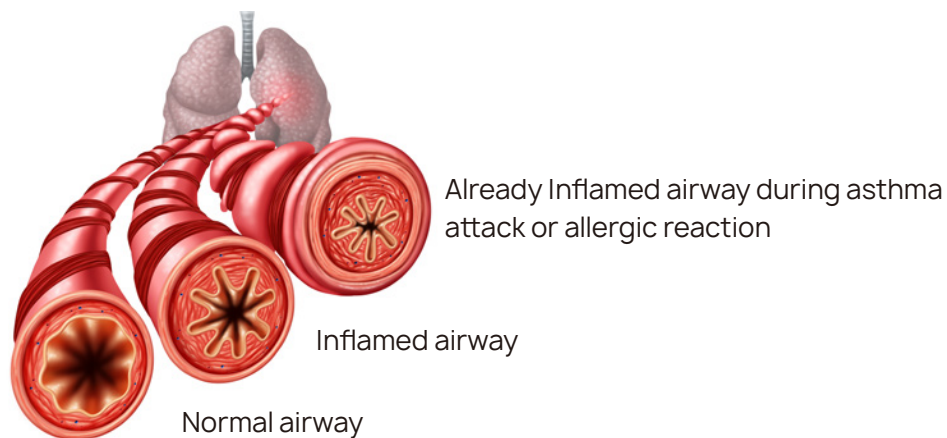
That means your allergy or asthma symptoms may be worse when you exposed to triggers after you have been exposed to ultrafine particles in your home or office. Airways which have already become inflamed due to the exposure to ultrafine particles are more easily enflamed further by the triggers. This can lead to much more severe symptoms.

For people with allergies and asthma, it is the sheer number of ultrafine particles in the air that causes problems. Ultrafine particles are everywhere and there are far more ultrafine particles than there are fine or large particles like pollen.



The danger of ultrafine particles arises because there are so many of them in the air – many times more than there are of the 0.3microns and larger particle sizes that HEPA filters are designed to remove. There are about 85 particles that are 0.3microns and larger in a cubic centimeter of air. But, as can be seen in the chart, there are approximately 4,000 particles/cm³ of that are around 0.02microns in size particle in indoor air and about 3,500 particles that are around 0.05microns and another 2,500 particles that are around 0.1microns²². With the other sizes of ultrafine particles, there are more than 10,000 particles/cm³. Adults breathe in about 500cm³ of air in each breath, so each breath we take indoors when there is no source of ultrafine particles contains more than 5 million ultrafine particles.

When ultrafine particles get all the way into the lower airways, they can get stuck and cause inflammation and can exacerbate the inflammation in the airways caused by other allergic triggers⁵. This increase in inflammation may be due to the large numbers, small size, surface area, and high penetration rate into the lining of the lungs and may not be due to their chemical composition or their mass^{16, 14}.

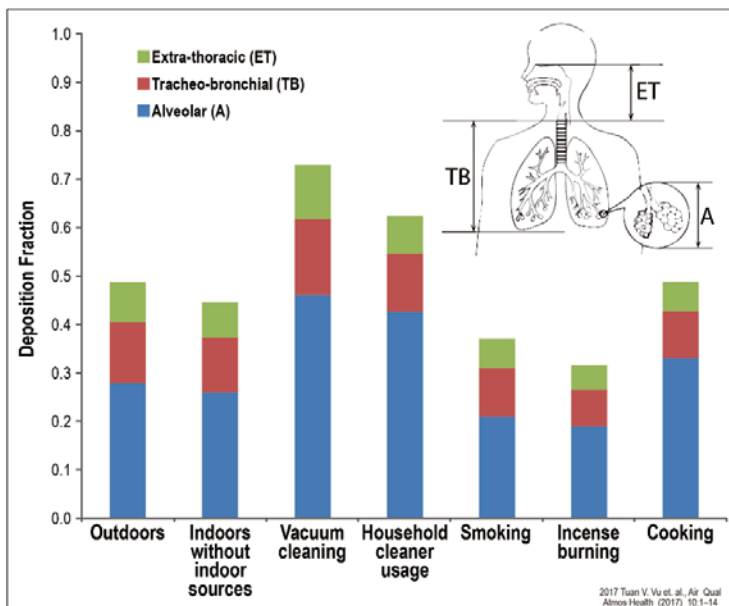


Damage from ultrafine particle exposure is cumulative

The damage from ultrafine particles appears to be cumulative. And, the exposure does not have to be on-going for it to have negative health impacts. Short-duration, high-intensity peak exposures like the peaks created by various household activities can contribute up to 25% of cumulative exposure at home⁹.

Dangers of Ultrafine Particles

In addition to inflammation caused by ultrafine particles, many of the ultrafine particles that we breathe become stuck inside our bodies where they can cause significant damage. The chart below shows the Deposition Fraction²² which is the percent of particles that are deposited in the lungs – particles that are inhaled but not exhaled – and where in the lungs those particles are deposited.



The smallest number of particles get deposited in the nose, mouth and upper throat, where mucus membranes are very efficient at removing particles. This is also where most of the large particles that could be removed by HEPA filters are deposited.

The orange shows the particles deposited in the upper parts of the lungs. Here too, the body has mechanisms, including mucus membranes, that remove the particles over time. The response of the mucus membranes to allergens and to ultrafine particles is one of the primary symptoms of allergies and asthma.

It has been shown that high pollen counts increase the likelihood of becoming infected with COVID-19 (SARS-CoV-2)⁸ and likely with other respiratory diseases as well. This may be due to the increased inflammation brought on by the pollen. If it is the inflammation that increases the likelihood of contracting COVID-19, then it is possible that the inflammation caused by ultrafine particles could also be a contributing factor to COVID-19 infections.

The largest portion of ultrafine particles, coded blue, are deposited deep in the alveolar sacs where oxygen is passed to the blood. Here the body's defense mechanisms work less efficiently. The inflammation caused can lead to a full-scale asthma attack. In addition, ultrafine particles are so small that they can pass through the lung along with oxygen and can enter the blood to be carried throughout the body.

Those ultrafine particles we inhale and which make it into the blood contribute to many diseases, such as heart diseases, including COPD, and to cancers and to kidney and many other diseases. Ultrafine particles, due to their extremely small size, can elude the body's defense mechanisms and are deposited in sensitive sites throughout the body such as in the bone marrow, lymph nodes, spleen, heart, brain, and the central nervous system¹⁵.



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Danger is Worse for Children

The danger of ultrafine particles is worse for children than for adults. For the same exposure, children receive a higher lung dose of ultrafine particles compared to adults as much as 50% higher in children than in adults. Asthma further increases the deposited fraction of ultrafine particles in children – 21% higher in asthmatic than in non-asthmatic children¹⁵.

When both the increased Deposition Fraction and minute ventilation were considered, the total number of particles retained in the lung was 74% greater in subjects with asthma than in healthy subjects⁶. This may contribute to increased susceptibility to the negative health effects of air pollution for people with asthma.

In-utero Exposure to Ultrafine Particles may cause some Asthma

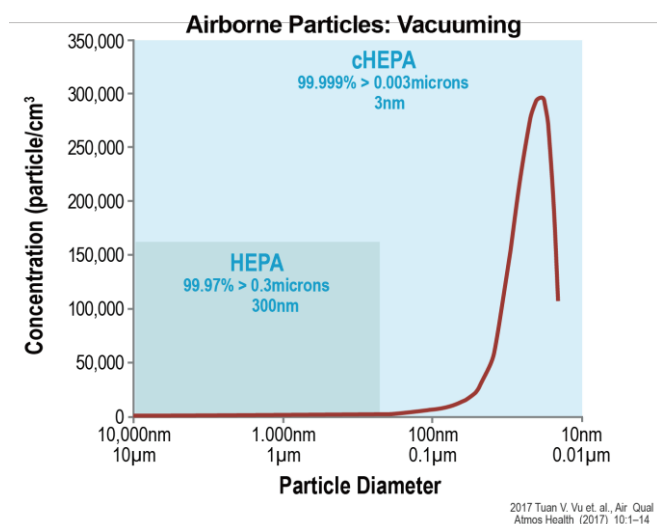
Exposure to airborne ultrafine particles not only exacerbates existing asthma, but it is also a risk factor for developing asthma¹². Researchers suggest that it may be this ability to pass through the lungs and into the blood that could be the mechanism that is associated with increased incidence of asthma in children whose mothers were exposed to high volumes of ultrafine particles while the child was in the womb when compared with children whose mothers were not exposed. The ultrafine particles seem to pass through the mother's blood, through the placenta and thereby into the circulatory system of the fetus.

In a longitudinal study among 160,641 live births in Toronto over a 6-year period, researchers found that second-trimester exposure to high levels of ultrafine particles was associated with childhood asthma in the children¹⁰. In another study, adolescents with asthma were found to have an approximately 30% increased risk for allergen sensitization because of prenatal exposure levels of ultrafine particles¹⁷.

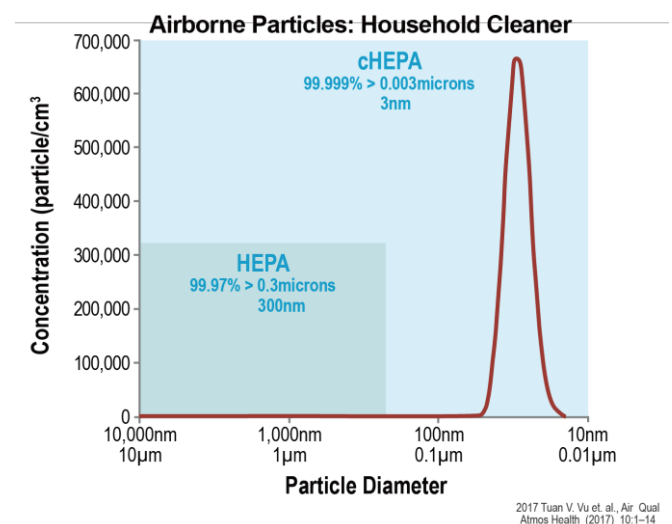
In addition to potentially increasing the risk of asthma and allergies in children, in-utero exposure to ultrafine particle damages pulmonary immune responses and increases the infant's susceptibility to respiratory infections and has a detrimental effect on the infant's overall long-term pulmonary health¹⁸.

Does Deep Cleaning Help?

People who suffer from allergies and who have asthma are often told to clean regularly to reduce their indoor allergen exposure. They are told that regular dusting and vacuuming helps reduce allergens. While this is certainly good advice for the removal of large allergens, it comes with a downside. Dusting, vacuuming and other cleaning also send ultrafine particles into the air.



Vacuuming launches an enormous cloud of ultrafine particles into the air. The largest number of particles, about 300,000 particles/cm³, centers around the 0.02micron diameter²². That is 75 times more than the highest numbers of ultrafine particles that are found in still indoor air. Using a common household cleanser can launch nearly 700,000 particles/cm³ into the air²².



Even though concentrations of ultrafine particles increased due to activities such as cleaning smoking and other things like burning candles or incense at home, the larger fine particles (PM_{2.5}) concentrations which HEPA filters are good at removing did not increase in the same fashion⁹.



So, What Can We Do?

Doctors and other medical professional recommend that people who suffer from allergies and asthma remove potential triggers from the air. This paper has shown that one of the most significant triggers is ultrafine particles. And, it has shown that there are other significant health risks to ultrafine particles. Finally, it has also shown that the effect of ultrafine particles is cumulative. Since we spend the majority of our time indoors, it makes sense to remove as many as possible of these ultrafine particles from the air we breathe.

Reducing the burden placed on the body by ultrafine particles means removing them from the air we breathe. Yet, traditional HEPA filters are not designed to capture ultrafine particles. What can help is a special cHEPA filter that has been developed by Airgle that removes particles down to 0.003microns - 100 times finer filtration than what is provided by the various types of HEPA filters.

Using cHEPA Filters Remove Ultrafine Particles from the Air

The cHEPA filter removes particles larger than 0.003microns – capturing 99.999% of ultrafine particles. Airgle air purifiers are the only air purifiers that are equipped with cHEPA filters.

cHEPA Filter removes 99.999% of particles >3nm (0.003µm)

MERV Rating	Air Filter will trap Air Particles size .03 to 1.0 microns	Filter Type ~ Removes These Particles
MERV 1	< 20%	Fiberglass & Aluminum Mesh ~ Pollen, Dust Mites, Spray Paint, Carpet Fibers
MERV 2	< 20%	
MERV 3	< 20%	
MERV 4	< 20%	
MERV 5	< 20%	Cheap Disposable Filters ~ Mold Spores, Cooking Dusts, Hair Spray, Furniture Polish
MERV 6	< 20%	
MERV 7	< 20%	
MERV 8	< 20%	
MERV 9	< 20%	Better Home Box Filters ~ Lead Dust, Flour, Auto Fumes, Welding Fumes
MERV 10	< 20%	
MERV 11	< 20%	
MERV 12	< 20%	
MERV 13	Less than 75%	Superior Commercial Filters ~ Bacteria, Smoke, Sneezes
MERV 14	75%~84%	
MERV 15	85%~94%	
MERV 16	95% or Better	
MERV 17	99.97%	HEPA & ULPA ~ Viruses, Carbon Dust, > 0.3 µm
MERV 18	99.997%	
MERV 19	99.9997% ← Airgle cHEPA	
MERV 20	99.99997%	

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