INBRIEF

Air Quality Affects Early Childhood Development and Health

For the full paper on which this brief is based, see Air Quality Affects Early Childhood Development and Health: Working Paper No. 3.

Beginning before birth, children's health and development are powerfully affected by influences from their developmental environment—the full range of experiences and exposures they have in the places they live, grow, play, and learn—with implications for their lifelong health and well-being.[1] **Clean air is an essential part of a healthy developmental environment, and ensuring that all of us have clean air to breathe in all the spaces where we spend time—indoors and out—offers a vital opportunity to support children's healthy development.**[2]

The importance of outdoor air quality for health has long been recognized. However, most adults spend more than 90% of their time enclosed in buildings and vehicles—and during pregnancy and early childhood, it's likely even more.[3,4] In these places, the air contains a wide range of particles and chemicals, some of which have the potential to adversely affect children's development and health. The Environmental Protection Agency estimates that levels of indoor air pollutants can be two to five times higher than outdoor levels due to poor ventilation; chemicals released from furniture, carpets, and cleaning products; indoor sources of pollution, such as byproducts of gas stove use; tobacco smoke; and outdoor pollution coming in due to "leaky" buildings and other factors.[5,6]

Not only are young children *exposed* to more indoor air pollutants, but they are also more *affected* by this pollution than most adults because they breathe more rapidly, they inhale a larger volume of air relative to their body size, and their respiratory, reproductive, endocrine, immune, digestive, and neurological systems are still developing—making them especially sensitive to exposures.[7] **The flip side of this increased sensitivity is the powerful opportunity it presents to support healthy development by improving indoor air quality, beginning even before birth.**

Center on the Developing Child
HARVARD UNIVERSITY

Air pollutants also disproportionately affect families with fewer resources and families of color because of discriminatory zoning, lending, and housing policies. These policies—both historical and current—have left a higher proportion of Black, Latine, and low-income families living in neighborhoods with lower-quality, substandard housing and school buildings compared with White and higher-income families.[8,9] These neighborhoods are also disproportionately zoned for heavy commercial and industrial uses that expose residents to more industrial air pollution and traffic.[8] **Solution strategies should prioritize marginalized communities as we work to improve air quality in the spaces where we spend the most time during pregnancy and early childhood.**

How Indoor Air Quality Affects Babies and Young Children

Current research offers important findings on the ways air quality affects young children's health and well-being, including:

- **Out-of-balance immune response:** When airborne particles, chemicals, and allergens pass through the lungs and into the body, they trigger the immune system to respond. Inflammation, an important part of our immune response, protects the body from both physical particles and toxic components absorbed on the particles.[10] But too much inflammation for too long, especially when the organs and brain are still developing, can weaken the immune system and contribute to lifelong inflammatory conditions such as heart disease, diabetes, and autoimmune disorders.[1]

- **Preterm birth:** Exposure during pregnancy to airborne particles and gases such as nitrogen dioxide is associated with an increased risk of premature birth and low birth weight, both risk factors for a range of neurodevelopmental problems in childhood and later in life.[11]

- **Diminished lung function:** Exposure to air pollution during pregnancy can restrict the amount of oxygen sent to the fetus through placental blood and may cause the lungs to develop with a lower capacity to breathe.[12]

- **Disrupted brain development:** In both early and later stages of brain development, the most common airborne particles can affect the brain, entering through nasal passages and passing across the protective blood barrier into the brain.[13] The regions of the brain where cells are most affected include those associated with memory, learning, reactivity to stress, and regulating emotions and behavior.[14]

- **Endocrine disruption:** Exposure to certain chemicals in the air can impact the body's endocrine system, which is responsible for regulating hormones. These chemicals can mimic thyroid activity, impact the start of puberty, and potentially disrupt developmental pathways during pregnancy and early childhood.[15]

- **Unequal multiplier effects:** There is likely a multiplier effect when stress and pollution—both known triggers for inflammation—combine to cause even greater, and longer-lasting, spikes in the inflammatory response.[1,10] For example, the combination of pollutants with high levels of psychosocial stress during pregnancy—such as significant stress caused by poverty, racism, mental illness, violence in the home or community, or environmental disasters such as wildfires—is associated with hypertension, preterm birth, and respiratory illness.[10,16]

To read about specific indoor air pollutants in children's environments, see the section "What Pollutes Indoor Air" in the Working Paper.

Effective Strategies to Improve Air Quality and Support Healthy Development

Just as policy decisions have shaped our air quality over time, new policy decisions can help make our indoor air cleaner, addressing disproportionate impacts on many marginalized communities while creating healthier developmental environments for all our children. Actionable solutions to improve indoor air quality already exist and range from policy and regulation options to healthier housing and furniture materials. Implementing these strategies is critically important to public health overall and could have broad benefits for children and their caregivers.

A balanced approach to cleaner indoor air requires implementing existing solutions and developing new ones at three key levels:

1. **Protect:** Take immediate actions to reduce harm.
2. **Adapt:** Allocate resources toward improving current systems, services, and infrastructure.
3. **Prevent:** Address the root causes of poor indoor air quality.

All these approaches are necessary, all have ready solutions, and all can contribute to improving the health and development of our children. And many communities and cities in the US and around the world are already successfully implementing such strategies with positive effects. Some examples of solutions include:

- **Monitor indoor air quality in early care centers and classrooms.** To improve air quality and protect children in the spaces where they spend time, those responsible for buildings need to know what substances are contaminating their air, where these pollutants come from, and how big the problem is. This can be done through inexpensive indoor air quality sensors.
- **Switch to safer building, cleaning, and other household products.** Commercial cleaning products, paints, and glues are a significant source of volatile organic compounds (VOCs) in indoor air.[17] Requiring the use of low-VOC products and products free of "forever chemicals," flame retardants, and phthalates in childcare facilities, schools, camps, and offices can protect children by reducing exposure during pregnancy and early childhood.[18]

- **Utilize portable, room-based air purifiers with HEPA filters.** These free-standing filters are cost-effective and can be useful when heating, ventilation, and air conditioning (HVAC) system updates are not possible or as an additional way to protect our children and ensure good air quality.
- **Make buildings healthier by adopting construction, maintenance, and oversight measures.** This includes strategies like using ventilation that controls indoor sources of odors, chemicals, and carbon dioxide and filters out at least 75% of particles; choosing supplies, furnishings, and building materials with low chemical emissions; and implementing a pest management plan.[19] For additional related strategies, see The 9 Foundations of a Healthy Building from Harvard's Healthy Buildings Program.
- **Develop and enact regional, state, and local policies and regulations.** Policies aimed at preventing outdoor air pollution by tackling pollutants at the source—such as supporting the transition from fossil fuels like coal and gas to cleaner energy forms—are critical to improving our indoor air quality as well. But they are insufficient without new regulations that specifically address indoor air quality, like requiring that the cleaning and building products, carpets, furniture, and cooking appliances we use in places where we spend the most time during pregnancy and childhood are safe and free of toxins. Additionally, regulations can limit bus and vehicle idling near schools and residential neighborhoods and require childcare centers and schools to be sited in areas with less air pollution.

To read more about these solutions and others, and find resources for taking action, see the full paper, Air Quality Affects Early Childhood Development and Health: Working Paper No. 3 and related Solutions Spotlight.

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