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Cleaner Air, Clearer Vision: Uncovering Air Pollution's Role in Childhood Myopia

Ryan Quigley:

For decades, the conversation around childhood myopia has focused on genetics, screen time, and education pressure. And while those factors *are* critical, new evidence suggests that another element may be quietly shaping young eyes: the air they breathe.

You're listening to *Eye on Ocular Health* on ReachMD, and this is an *AudioAbstract*. I'm Ryan Quigley, and today, I'll be diving into new findings from a large, machine learning-based study that examined how air pollution may influence uncorrected visual acuity in nearly 30,000 school-aged children across East Asia.

For some background, myopia prevalence in this region is among the highest in the world. Up to 90 percent of school-leavers are affected, and as many as one in five have high myopia.

So to uncover if air quality played any part in driving this trend, researchers from Tianjin Medical University applied machine learning to a multifactorial dataset combining genetics, behavioral habits, school environment, and environmental exposures. Their model included not only PM2.5 and nitrogen dioxide levels, but also greenspace, nighttime lighting, dietary factors, and more.

Their main goal was to identify the key contributors to vision outcomes and estimate how much visual acuity might improve under modeled scenarios of cleaner air.

Using gradient boosting machines and SHAP explainability, the researchers found that nighttime light and parental myopia were the largest influential factors. But lower levels of nitrogen dioxide and PM2.5 were independently associated with better uncorrected visual acuity, even after adjusting for confounding factors like parental myopia, school type, and daily habits.

The effect, however, wasn't uniform. Children with mild to moderate myopia, which is often referred to as "school myopia," were more responsive to pollution reduction than those with high myopia. And younger students, especially those in primary school, showed the greatest predicted improvement in vision.

In modeled scenarios where pollution was reduced to the levels of the lowest-exposure quintile, the average primary student's vision improved by approximately 0.09 units on the visual acuity scale. That's more than *double* the predicted gain for the overall student group.

So why might this age difference exist? One hypothesis is that younger eyes are more plastic, more vulnerable, and more responsive to environmental changes. Primary students may also spend more time outdoors, increasing their exposure to pollutants and potentially amplifying the benefit of cleaner air.

While these results are still observational, the modeling and subgroup analyses strengthen the plausibility of these associations. In prior studies, chronic exposure to PM2.5 has been linked to ocular surface inflammation, oxidative stress, extracellular matrix remodeling and scleral elongation. Nitrogen dioxide, which is commonly emitted by vehicles and industrial sources, may contribute to these pathways through oxidative and inflammatory stress, although its role is less directly established.

But despite that unknown, the potential implication of these findings is clear: If cleaner air is associated with even *modestly* better vision, then air quality becomes a modifiable factor in the myopia equation.

So what could this mean for policy and practice? The researchers suggest a few actionable ideas, which aren't just environmental wins, but public health strategies. These include:

- Installing portable air-cleaning units in schools,
- Establishing low-emission zones around campuses, and
- Encouraging outdoor time during periods of good air quality.

Naturally, though, there are some important limitations to note. All data came from one urban area in China, so generalizability may be limited. Additionally, exposure was estimated at the community level rather than individually, and many behavioral variables were self-reported.

But even with these limitations, this study suggests a new frontier in myopia prevention: environmental exposures. Cleaner air won't replace corrective lenses or eliminate genetic risk, but it may offer a scalable, population-level intervention, especially if we act early.

This has been an *AudioAbstract* for *Eye on Ocular Health*, and I'm Ryan Quigley. To access this and other episodes in our series, visit ReachMD.com, where you can Be Part of the Knowledge. Thanks for listening!

Reference

Chen X, Dai Y, Wei R, et al. Benefits of clean air for school children's vision health. *PNAS Nexus*. 2025;4(9):pgaf279. doi:10.1093/pnasnexus/pgaf279