Early-life exposure to air pollution causes changes in brain connectivity in preadolescents

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Higher exposure to air pollution is associated with higher functional brain connectivity among several brain regions in preadolescents, while exposure to traffic noise was not, according to a study led by ISGlobal. The findings also identify the first years of life as the most sensitive

period of exposure to air pollution.

Traffic-related air pollution and noise are affecting an increasing number of people worldwide. "We already know that children are particularly vulnerable to the effect of these exposures, because of their immature metabolism and developing brain," says ISGlobal researcher and senior author Mónica Guxens. In fact, several studies by Guxens and others have found an association between exposure to traffic-related air pollution during early childhood and alterations in the brain structure.

In this study, the research team used magnetic resonance imaging (MRI) to explore whether higher exposure to air pollution or noise could also be associated with possible alterations in brain connectivity (i.e. the way in which different brain regions interact). "The use of MRI has opened up new possibilities in epidemiological research for investigating the structure and the functioning of the brain," says Guxens.

The researchers used data of 2,197 children from the Generation R Study, born between April 2002 and Jan 2006 and living in Rotterdam, the Netherlands. Using land use models, they estimated levels of nitrogen oxides (NO_x and NO_2) and particulate matter (PM) at the participants' homes at different time periods: during pregnancy, from birth to three years, from three to six years, and from six years of age to the age at which the MRI scan was performed. Noise levels due to traffic road were estimated using existing noise maps. Between nine and 12 years of age, the participants were invited to undergo an MRI scan in the resting state (i.e. with no external stimuli).

The findings show that higher exposures to NO_2 and $PM_{2.5}$ absorbance (an indicator of black carbon particles) from birth to three years, and to NO_x from three to six years of age were associated with higher functional brain connectivity among several brain regions in the preadolescents.

The associations were identified in brain areas predominantly involved in two networks that have strongly opposing functions: the task negative (or "default-mode") network tends to be activated in resting conditions and the task positive network tends to be activated during tasks that demand attention.

"We still have to understand the consequences of this increased activity of both networks in resting conditions, but for now we can say that the brain connectivity in children exposed to higher levels of air pollution is different from what we would expect," says Laura Pérez-Crespo, first author of the study.

The period from birth to three years was the one with the highest susceptibility to air pollution, and black carbon was the pollutant most associated with brain connectivity changes. As the authors note, the main source of black carbon and nitrogen oxide gases in European cities are diesel vehicles. Noise exposure at home was not associated with differences in brain connectivity, even though several studies show that noise affects cognitive development in children.

The research was published in *Environment International*.

More information: Laura Pérez-Crespo et al, Exposure to traffic-related air pollution and noise during pregnancy and childhood, and functional brain connectivity in preadolescents, *Environment International* (2022). DOI: 10.1016/j.envint.2022.107275

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