Evidence of Alzheimer's, Parkinson's, and MND in Brains of Young People Exposed to Air Pollution

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Researchers looking at the brainstems of children and young adults exposed lifelong to air pollution in Mexico City have discovered disturbing evidence of harm.

Previous studies have linked fine particulate air pollution exposure with Alzheimer's disease, and researchers have also reported evidence of air pollution-derived nanoparticles in the frontal cortex of the brain.

But after examining the brainstems of 186 young Mexico City residents aged between 11 months and 27 years of age, researchers, including Professor Barbara Maher from Lancaster University, found markers not only of Alzheimer’s disease, but also of Parkinson’s and of motor neurone disease (MND) too.

These markers of disease were coupled with the presence of tiny, distinctive nanoparticles within the brainstem – their appearance and composition indicating they were likely to come from vehicle pollution.

This has led researchers to conclude that air pollution of this nature – whether inhaled or swallowed – puts people at risk of potential neurological harm.

The brainstem is the posterior part of the brain which regulates the central nervous system, controls heart and breathing rates, and how we perceive the position and movement of our body, including, for example, our sense of balance.

Professor Maher said: “Not only did the brainstems of the young people in the study show the ‘neuropathological hallmarks’ of Alzheimer’s, Parkinson’s and MND, they also had high concentrations of iron-, aluminium- and titanium-rich nanoparticles in the brainstem – specifically in the substantia nigra, and cerebellum.

“The iron-and aluminium-rich nanoparticles found in the brainstem are strikingly similar to those which occur as combustion- and friction-derived particles in air pollution (from engines and braking systems).

“The titanium-rich particles in the brain were different - distinctively needle-like in shape; similar particles were observed in the nerve cells of the gut wall, suggesting these particles reach the brain after being swallowed and moving from the gut into the nerve cells which connect the brainstem with the digestive system.”

The ‘neuropathological hallmarks’ found even in the youngest infant (11 months old) included nerve cell growths, and plaques and tangles formed by misfolded proteins in the brain. Damage to the substantia nigra is directly linked with the development of Parkinson’s disease in later life. Protein misfolding linked previously with MND was also evident, suggesting common causal mechanisms and pathways of formation, aggregation and propagation of these abnormal proteins.

The one thing common to all of the young people examined in the study was their exposure to high levels of particulate air pollution.

Professor Maher says that the associations between the presence of damage to cells and their individual components – especially the mitochondria (key for generation of energy, and signalling between cells) – and these metal-rich nanoparticles are a ‘smoking gun’.

Such metal-rich particles can cause inflammation and also act as catalysts for excess formation of reactive oxygen species, which are known to cause oxidative stress and eventual death of neurons. Critically, the brainstems of age- and gender- matched controls

who lived in lower-pollution areas have not shown the neurodegenerative pathology seen in the young Mexico City residents.

These new findings show that pollution-derived, metal-rich nanoparticles can reach the brainstem whether by inhalation or swallowing, and that they are associated with damage to key components of nerve cells in the brainstem, including the substantia nigra.

Even in these young Mexico City residents, the type of neurological damage associated with Alzheimer's, Parkinson's and motor neurone diseases is already evident. These data indicate the potential for a pandemic of neurological disease in high-pollution cities around the world as people experience longer lifespans, and full symptoms of earlier, chronic neurological damage develop.

Professor Barbara Maher said: "It's critical to understand the links between the nanoparticles you're breathing in or swallowing and the impacts those metal-rich particles are then having on the different areas of your brain.

"Different people will have different levels of vulnerability to such particulate exposure but our new findings indicate that what air pollutants you are exposed to, what you are inhaling and swallowing, are really significant in development of neurological damage.

"With this in mind, control of nanoparticulate sources of air pollution becomes critical and urgent."

Read the original article on Lancaster University.