

**The Psychological, Neurological, and Socioeconomic Effects of Environmental Pollution on
Human Growth and Development**

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Introduction

Alzheimer's, Dementia, and Parkinson's are diseases that significantly impair cognitive functioning and are irreversible without treatment. Studies show that the development of these diseases may not only be caused by genetics but also environmental factors, specifically exposure to chemicals. In this review, we will consider different sources and relate exposure of certain chemicals to the onset of a cognitive disease, from three different perspectives: scientific, socioeconomic, and psychological.

Neural and Molecular Substrates of Alzheimer's Disease/Dementia

Alzheimer's Disease (AD) is a progressive neurodegenerative disease characterized by a cognitive decline that typically affects memory first and then executive functions, language, and visuospatial skills. Alzheimer's is one of the most common causes of dementia. The primary cause of AD is unknown, but it tends to come with age, except in a small number of familial cases driven by genetic mutations (DeTure). The frontal lobe and hippocampus in the brain are affected the most; these parts of the brain control attention and memory. In atypical AD, language, motor abilities, frontal and executive capacities, or visuospatial skills are the most prominent and early deficits. These atypical clinical features are associated with an unusual pattern of NFT (neurofibrillary tangles) or SP (senile plaque) formation that predominantly involves cortical areas usually spared in the course of the degenerative process. Probable AD corresponds to a typical clinical syndrome whereas possible AD is suggested when the observed clinical features are at odds with the typical syndrome (Gunten).

The sequence of cognitive deterioration is thought to reflect the progressive invasion of the cerebral cortex by the two major pathological hallmarks of AD, neurofibrillary tangles and amyloid/senile plaques, as well as neuronal and synaptic loss. Amyloid plaques are hard,

insoluble accumulations of beta amyloid proteins that clump together between the nerve cells (neurons) in the brains of AD patients. NFTs are thick bundles formed near the cell surface of affected neurons (Gunten).

Effects of Air Pollution On The Brain

Air pollution affects the Central Nervous System (CNS), specifically its cognitive function, therefore increasing risk of AD and dementia. It also increases risk of stroke (Calderón-Garcidueñas et al.). Air pollution can damage the developing brain, which is especially concerning because this damage can impair cognitive function across the life span causing the development of cognitive diseases earlier on in life.

A study done by Calderón-Garcidueñas et al. in Mexico City found that children living in more polluted areas had worse cognitive performance and more prefrontal brain lesions on MRI. By living in these conditions, children are disadvantaged and are at a higher risk of cognitive diseases. Air pollution is also harmful to the aging brain. Older adults who are more heavily exposed to air pollution perform worse on cognitive testing and are at an increased risk of dementia compared to less exposed adults. Long-term exposure to air pollution is associated with a smaller brain volume, according to Magnetic Resonance Imaging (MRI) scans. Short term exposure to fine particles increases the risk of hospitalizations in Parkinson's Disease. As shown, the effects of air pollution can be fatal, increasing risk of cognitive diseases in individuals ranging from young children to older adults. Thus, measures must be taken to help decrease air pollution in residential areas.

Socioeconomic Status and its Relation to the Development of Cognitive Diseases

Many cognitive diseases, including Parkinsons and Dementia, are found to have a strong correlation with exposure to toxic chemicals. People that have a lower overall income tend to

live in areas closer to manufacturing plants and other producers of dangerous chemicals due to the lower cost of homes in these areas. A study conducted by Wellenius et al. used results from the Boston MOBILIZE study to explore the relationship between distance of residents to major roadways and pollutants and high black carbon levels. The study was conducted by testing elderly (seventy-eight year olds) with different proximities to major roadways using the Hopkins Verbal Learning Test, trail making test performance, and letter and category fluency. They found that Black Carbon levels were only associated with impaired immediate recall, meaning that people living close to these plants were at greater risk of developing mild Dementia.

Along with those living near chemical plants, many individuals work in occupational and electrical industries, which would thoroughly raise the likelihood of exposure to these toxic chemicals. For many, these informal and low-skill jobs are the only way to support a family. A study done by Goldman et al. examined the association between occupational/electrical work and the development of PD. By using 99 sets of twins in this study, Goldman and his team were able to decipher what tasks, activities, and jobs may have led to the onset of a cognitive disease. Most of these twins were genetically identical so Parkinsons could not have been hereditary, but rather influenced by certain occurrences in either twin's life. Researchers found that exposure to TCE and PERC were associated with the development of PD. TCE, also known as Trichloroethylene, is used to make refrigerants and a degreasing solvent for metal equipment. TCE is already flagged as a cancer-causing substance, but millions of pounds are still used annually, endangering many of those unaware of its alarming impacts. On the other hand, PERC (Tetrachloroethane), a manufactured chemical used for the dry-cleaning of clothes and other substances, was removed from all U.S markets in 2020. These studies and many more highlight the unlivable conditions that come along with a lower economic status and how change should

be made to insure all people are safe from risk.

How Lead Exposure Can Impact the Brain and Result in the Onset of Neurodevelopmental and Psychological Disorders

The onset of several cognitive, neurodevelopmental, and psychological disorders are associated with the spread of environmental pollution, or the exposure of toxic substances. In this case, pollution was shown to have a significant impact on one's personality and psychological health. A study done by Schwaba et al. showed that even low-level lead exposure results in devastating lifelong consequences, such as negatively affecting normal-range personality traits. The study utilizes the associations between childhood atmospheric lead exposure and adult personality traits in the United States. Furthermore, using a natural experiment, they examined the effects of lead-based products manufactured in the 1970s (as lead-based products were prominent around that time). By linking historic atmospheric lead data from 269 US counties and 37 European nations to personality questionnaire data from over 1.5 million people that grew up in their respective areas, the researchers in the study obtained results that revealed participants to be less agreeable, less conscientious, and more neurotic. In essence, more lead exposure leads to more drastic effects on one's personality.

Early-child lead exposure is also linked to schizophrenia, a serious mental disorder. Garcia et al. performed a study that specifically uses human and animal experimental data to substantiate an association between childhood lead exposure and schizophrenia. Furthermore, the researchers found that $Pb(2+)$ - induced changes in neurotransmitter receptors that oversee the actions of drugs (drugs that are often associated with addiction) increase one's susceptibility to drug abuse and addiction. In conclusion, early-life lead exposure, or in this case, environmental pollution, leads to the danger of being afflicted with schizophrenia, one of many mental

disorders, as well as the risk of lifelong addiction.

Gaps in the Literature

Chemicals and pollution in the air have several negative effects; they can affect many parts of the brain and increase the risk of developing cognitive diseases and cancer. People who live near major roadways, factories, or other chemical-producing sites often feel the highest effects of pollution. Because some individuals can't control their living situation due to conditions such as poverty, measures should be taken to reduce air pollution and remove certain chemical-producing sites. Industries that work with toxic chemicals should create safer systems that protect nearby citizens' health. By being cautious and resourceful, the wellbeing of residents can be better protected. To help with pollution in general, individuals can use fewer plastic materials such as bags and straws, and find ways to save energy such as turning off lights when they're not being used. As mentioned in the psychological aspect of the impact of environmental pollution, toxic substances, such as lead, can lead to harmful effects in terms of people's personality traits—as seen in the study done by Ted Schwaba et. al. However, the study's data collection was not very clear on whether their data findings could be generalized to all young age groups as well as all other geographical regions than the ones tested. Nevertheless, it is important to note that there is a negative correlation with any level of lead exposure; more lead exposure results in a decrease in the “personality trait score” as well as increased risk of drug addiction. In turn, it can pose a significant risk to childrens' physical and mental health.

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