Effects of Air Quality on Cognitive and Motor Scores

Shivangi Sarkar, Sydney Y. Schaefer, PhD[a] and Andrew Hooyman PhD, Gstat[b]

[a]Ira Fulton School of Engineering, Arizona State University, Tempe, AZ

[b]Crean College of Health and Behavioral Sciences, Physical Therapy, Chapman University, Irvine, Ca

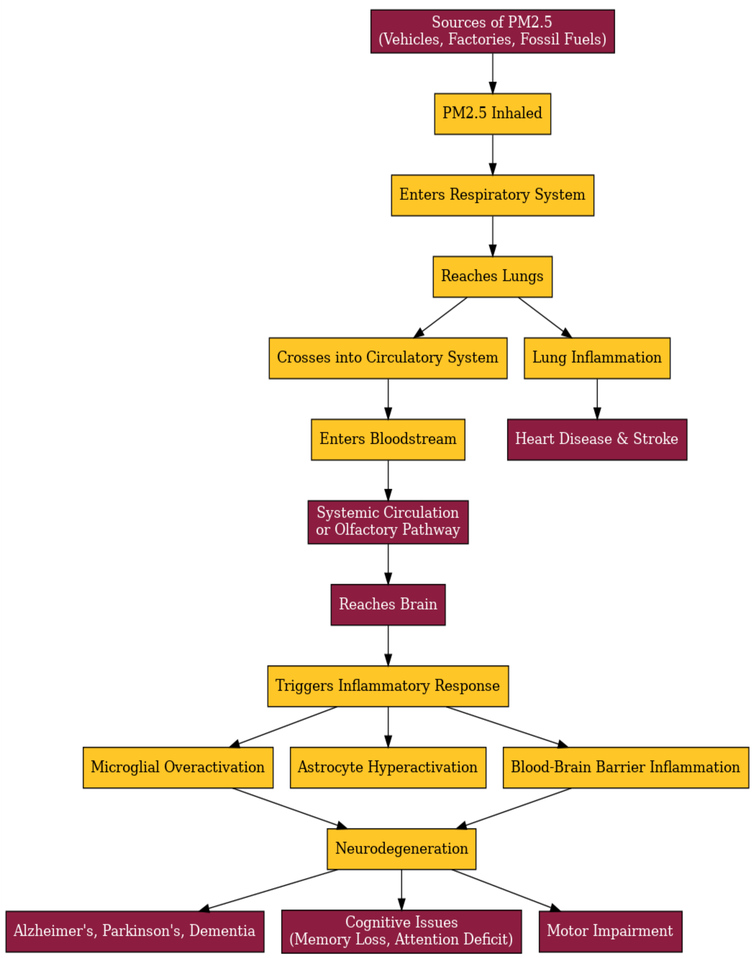
Introduction

Air quality is crucial for both environmental and human health. Exposure to polluted air can lead to respiratory and neurological disorders. Poor air quality often results from urbanization, industrialization, and fossil fuel use. Harmful components in air pollution include particulate matter (PM), carbon monoxide (CO), ozone, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and other pollutants. Major sources of fine particulate matter (PM2.5) include vehicle emissions, factory operations, and the burning of fossil fuels.

Introduction

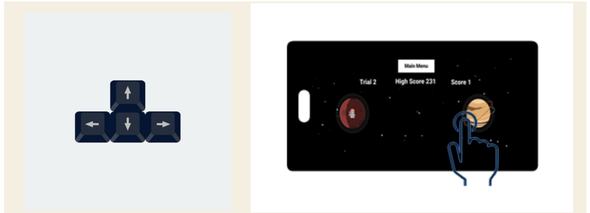
The objective is to analyze the correlation between poor air quality and motor performance. This link will allow us to understand how air pollution, specifically PM2.5 impacts human behavior, specifically the ability to learn a motor skill. Understanding this will help us understand the harmful impact of poor air quality to humans.

Background



Methods

Motor Skill Test (Super G): 1,397 participants played Super G to assess motor performance (response time, position, acceleration, trials completed).
Air Quality Data: EPA AQI and PM2.5 data (2023–2024) were matched to participant zip codes using geosphere (R package).
Data Analysis: Used R (ggplot2, geosphere, dplyr) to calculate mean PM2.5, perform linear regression, and compare motor improvement between high and low PM2.5 exposure groups.



PC and Desktop Controls use Arrow Keys

Mobile and Tablet Controls use touchscreen

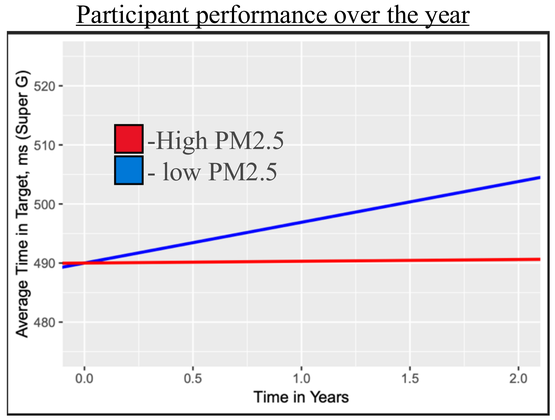
RESULTS

Air Quality Trends: (Figure 1, 2, 3, 4)
- Most counties had AQI values **below 50** (good air quality).
- Some counties showed **higher AQI**, indicating pollution.

•**Proximity to Monitoring Sites**
- Most participants lived **within 10km** of a monitoring site.
- Some were **50km+ away**, increasing uncertainty in air exposure levels.

•**PM2.5 Exposure & Motor Performance**:
- Participants exposed to **lower PM2.5** improved in motor skill performance.
- **Higher PM2.5 exposure led to no improvement** (cognitive/motor decline).

Participant performance over the year



High PM2.5 (red) and low PM2.5(blue) exposed participants improvement of the task over years

Summary, Conclusions and Future Directions

Discussion

Higher PM2.5 exposure was associated with reduced motor skill improvement over time. PM2.5 can enter the brain via the bloodstream or olfactory nerve, where it triggers chronic inflammation, oxidative stress, and damages neurons. This leads to impaired motor function, likely affecting brain regions such as the motor cortex and cerebellum.

Additionally, PM2.5 weakens the blood-brain barrier, allowing further harmful particles to accumulate and worsen neurodegeneration. Chronic exposure is also linked to sarcopenia, contributing to physical motor decline.

Our findings emphasize that air pollution is not only a respiratory risk but also a serious threat to brain health and motor ability. Reducing PM2.5 exposure could be critical for preserving both cognitive and physical functions.

Future Directions

Future research should focus on in vivo animal studies to explore the direct biological effects of PM2.5 exposure on motor learning and brain inflammation. Controlled animal models would allow detailed analysis of neuroinflammatory pathways, oxidative stress, and motor function impairments over time. Additionally, conducting studies in regions with higher levels of air pollution could provide deeper insights into the severity of neurological impacts under real-world environmental conditions.

References

SCAN ME

Ira A. Fulton Schools of Engineering
Arizona State University