Washington University in St. Louis
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Effects of Air Pollutants on Neuroimaging Measures Diverge by HIV Status

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Background

The U.S. National Assessment of the Potential Consequences of Climate Variability and Change predicts that individuals living with HIV (PLWH) will be exceptionally vulnerable to climate-sensitive health outcomes[1]. Most literature on HIV and pollution examines international cohorts, emphasizing childhood development, risks of infection and cardiovascular effects. We look at a community-dwelling cohort of older PLWH in the greater St. Louis area. We evaluate the effects of common air pollutants, including fine particulate matter (PM2.5) and ozone on cognitive performance and brain structure, while simultaneously taking into account socioeconomic status as measured by Area Deprivation Index (ADI).[4]

Methods

Participants

- Recruitment Sites: Infectious Disease Clinic and AIDS Clinical Trial Unit at WUSTL
- 290 community dwelling individuals in the Greater St. Louis Area (208 PLWH, 82 uninfected controls)

Data Collected

- 290 community dwelling individuals in the Greater St. Louis Area (208 PLWH, 82 uninfected controls)
- Structural MRI, single timepoint
- Full battery of cognitive tests, across 5 domains
- Participant Mailing Address

Spatial Data Generated

- Applied spatial interpolation to publicly available EPA pollution monitoring data to calculate average exposure to pollutants (PM2.5 and Ozone) in the week prior to study visit (based on participant - provided mailing address)
- Extracted Area Deprivation Index (ADI) based on participant – provided mailing address census tract

EPA Monitoring Site Distribution

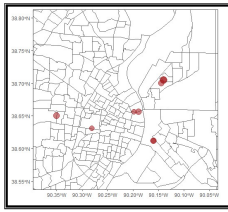


Figure 1: EPA Monitoring Sites[2] are primarily clustered around the central corridor of the St. Louis Metro Region. Future collaborations with additional air and particulate matter monitoring sites are currently being explored to enhance the quality of interpolated data.

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Results

Demographics

	Uninfected Control	PLWH	Overall	p
N	82	208	290	
Age	49.2 (14.6)	52.7 (11.0)	51.7 (12.2)	0.027
Sex (% Male)	43 (52.4%)	156 (75.0%)	199 (68.6%)	<0.001
Education (Years)	13.9 (2.19)	13.2 (2.63)	13.4 (2.53)	0.032
Race				0.651
Black	45 (54.9%)	130 (62.5%)	175 (60.3%)	
White	36.0 (43.9%)	74.0 (35.6%)	110 (37.9%)	
Multiracial	1 (1.2%)	2 (1.0%)	3 (1.0%)	
Not Reported	0 (0.0%)	2 (1.0%)	2 (0.6%)	
ADI	67.1 (24.0)	70.7 (25.3)	69.7 (25.0)	0.277
Detectable Viral Load (% Detectable)	NA	31 (14.9%)	31 (10.7%)	NA

Brain Structure

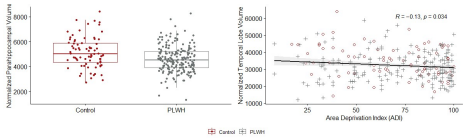


Figure 2. We assessed 6 regions (frontal lobe, temporal lobe, medial temporal lobe, parahippocampus, hippocampus and cortical white matter), testing for effects of HIV, ADI, and pollutant exposure while controlling for differences in age, sex and education. The parahippocampus was smaller in PLWH; greater ADI associated with smaller temporal lobes.

Cerebral Blood Flow

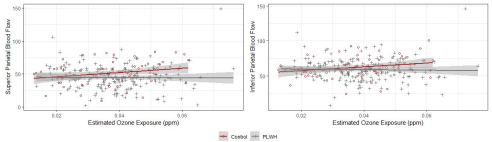


Figure 3. We assessed 7 regions (amygdala, caudal anterior cingulate, rostral anterior cingulate, hippocampus, superior parietal, inferior parietal and frontal lobe), testing for effects of HIV, ADI, and pollutant exposure while controlling for differences in age, sex and education. Parietal lobe blood flow was affected by ozone exposure, but response varied by HIV status

Cognitive Performance

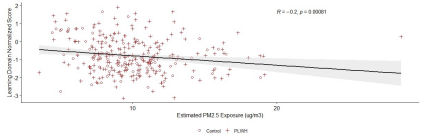


Figure 4. We assessed 5 cognitive domains (learning, memory, executive function, motor and language), testing for effects of HIV, ADI, and pollutant exposure while controlling for differences in age, sex and education. Learning was affected by recent PM2.5 but not ozone exposure.

[1]Gleick et al, 2020 [2]epa.gov; accessed 2021 [3]Clavo et al, 2004 [4]Kind et al, 2014

Conclusions

- In St. Louis, neighborhood level SES is not correlated with pollution exposure (R = -0.03, p = 0.65). These results may not generalize to regions where there is a high correlation between pollutants and poverty
- ADI and HIV, but not recent pollutant exposure, effect brain structure. This makes sense, as these are chronic and pollution exposure is subject to greater fluctuation.
- We identify a divergent response to ozone, stratified by HIV status.
  - Prior stroke literature identifies increased blood flow in response to ozone[3]
  - Further work is required to understand the mechanism behind the non-response to ozone in PLWH, as well as potential implications of this non-response
- For every 10 μg/mL increase in recent PM2.5 exposure, participants perform about 1 standard deviation worse in learning-related tasks.

Area Deprivation Index

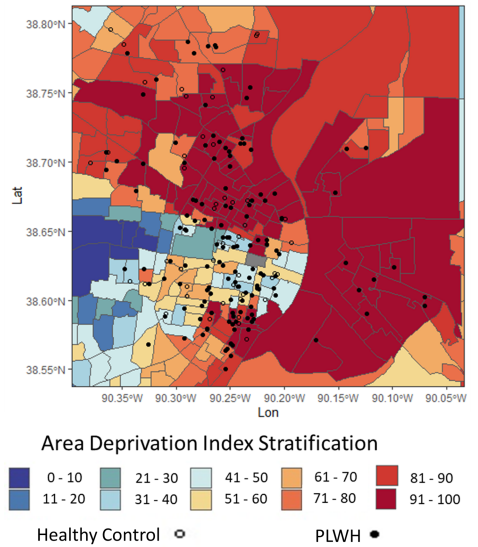


Figure 5: This 100 point scale[4] classifies census-tract level neighborhood characteristics to identify areas of high deprivation (max score = 100), suggesting low income and reduced access to healthcare/employment.