The Role of Environmental Risk Factors in Preschoolers' Self-Regulation and Verbal Abilities

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Background

Exposure to environmental stressors, such as fine particulate matter (PM 2.5) and high-level noise exposure, can decrease school readiness in children and increase susceptibility to health problems in the future.

Purpose

The purpose of this study was to explore the relationships between environmental stressors, self-regulation, and verbal abilities in preschoolers.

Figure 1. Definitions of the variables examined in the study.

The CREATE Study

- The **C**umulative **R**isk, **E**arly Development, and Emerging **A**cademic **T**rajectori**E**s (CREATE) is a pilot project and seeks to examine how home, school, and outside environments are related to stress biomarkers and childhood development.
- CREATE also provides data to analyze the relationships among a wide range of environmental stressors and individual variables with children's development, including the development of self-regulation and receptive vocabulary.
- Assessments were taken at the participants' primary residences and administered in a standardized order.
- The CREATE database was used to analyze 26 preschoolers aged 3-4 (M = 4.08) and their primary caregivers.

Measures

Air Quality Exposure

PLANTOWER PM3003, monitors that assessed fine particulate matter (PM 2.5) exposure; monitors were placed into two stationary areas (participants' preschool classroom and homes) and into a backpack to measure child's personal air exposure.

Noise Exposure

Language Environment Analysis System (LENA), a personal device that records 16 hours of the child's auditory environment, which a software program will categorize into components considered functional and non-functional noise

Self-Regulation

Global Assessment of Self-Regulation: Head-Toes-Knees-Shoulders (HTKS)

Shifting Attention: Dimensional Change Card Sort (DCCS)

Working Memory: standardized and normed verbal (VWM) and nonverbal (NVWM) working memory subsets of Stanford-Binet Intelligence Scales, 5th Edition

Child Verbal Ability

Peabody Picture Vocabulary Test (PPVT), IV, a standardized assessment of receptive vocabulary appropriate for use with individuals' ages 2 years, 6 months to 90 years (Dunn & Dunn, 2007)

Figure 2. Assessments utilized to measure the study variables.

Measures

Air Quality Monitors Air quality was measured using two stationary and one personal monitor (PLANTOWER PM3003, Duke University) for each participant. All three monitors were identical and collected ultra-fine and fine particulate matter (PM2.5 & PM10), carbon monoxide, temperature, and humidity data every minute.

Noise and Language Environment The child's personal exposure to nonfunctional noise was measured using the Language Environment Analysis System (LENA Research Foundation, 2015). The LENA system is a personal device that records 16 hours of the child's auditory environment. In addition to having a decibel reader, it disentangles multiple sources of noise.

Measures

Receptive Vocabulary *The* Peabody Picture Vocabulary Test, IV (PPVT-IV) is a standardized assessment of appropriate for use with individuals' ages 2 years, 6 months to 90 years. This measure assesses receptive vocabulary, the words in individual can comprehend.

Self-Regulation Self-regulation was assessed using multiple measures that will be composited for analysis. Head-Toes-Knees-Shoulders (HTKS) is a global assessment of self-regulation, the ability to control thoughts, behaviors, and emotions to achieve a goal. The standard and advanced, "border" versions of the Dimensional Change Card Sort (DCCS) was used to assess ability to shift attention. Verbal Working Memory (VWM) and Nonverbal Working Memory (NVWM) was assessed using the standardized and normed verbal (VWM) and nonverbal (NVWM) working memory subtests of the Stanford-Binet Intelligence Scales, 5th Edition.

Analysis Plan

This study examined correlations of children's average PM2.5 and average decibel exposure over a 48-hour period with their receptive vocabulary and their scores on the individual self-regulation abilities tasks (Figure 3; Table 1).

Results

We found that PM(2.5) was significantly related to receptive vocabulary (r = 0.30, p = 0.03). PM2.5 was not associated with any of the self-regulation variables. The noise variables were not associated with receptive vocabulary or the self-regulation variables (all p's > 0.05)

	HTKS	DCCS	SB5	Self-Regulation	% of seconds with TV/Electronic Noise	% of Time where Average Decibel Readings > 80 dB	PPVT
HTKS	1	.439*	.201	.635**	-.166	-.067	.401*
DCCS	.439*	1	.592**	.261	-.156	.000	.226
SB5	.201	.592**	1	.777**	-.250	-.282	.558**
Self-Regulation	.635**	.261	.777**	1	-.278	-.127	.534**
% of seconds with TV/Electronic Noise	-.166	-.156	-.250	-.278	1	.077	.185
% of Time where Average Decibel Readings > 80 dB	-.067	.000	-.282	-.127	.077	1	-.167
PPVT	.401*	.226	.558**	.534**	.185	-.167	1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 1. Correlations among study variables.

Results

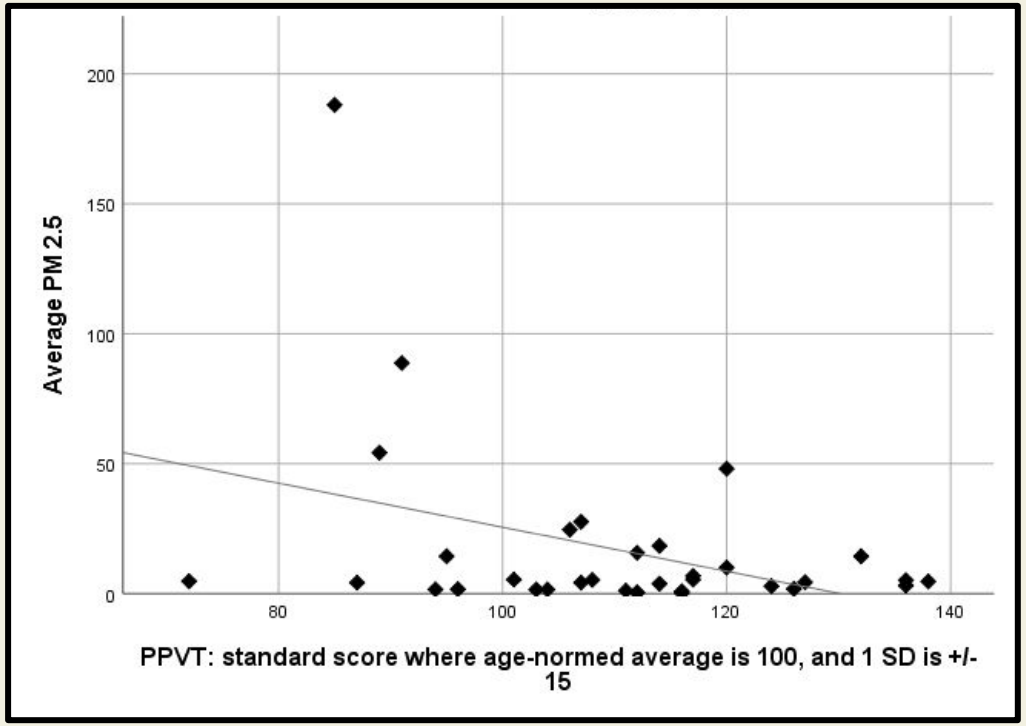

Figure 3. Scatter plot of average PM(2.5) and standard PPVT scores.

Higher PM 2.5 Levels Predict Lower PPVT Scores in Preschoolers

Higher levels of PM 2.5 were associated with lower PPVT performance in preschoolers ($r=-.30$, $p< .05$).

Discussion

- This pilot study provides preliminary data suggesting that preschoolers' exposure to air pollution in the form of PM2.5 may have reduced receptive vocabulary.
  - It might be that young children have limited ability to detoxify and eliminate contaminants found in the environment (Myhre, Lag, Villanger, et al., 2018).
  - Children are the most at risk for exposure due to their "faster breathing rate, thus, a greater likelihood of inhaling larger amounts of pollutant-contaminated air" (Liu, Dunea, Iordache, et al., 2018).
- However, the small sample size prevents us from being able to establish cause. Studies with larger sample sizes are necessary to confirm adverse developmental outcomes for preschoolers who exposed to PM 2.5.
- Our nonsignificant findings for noise exposure were surprising and may reflect the limitations of our sample size. It was difficult to find direct effects with such a small sample, thus it would require further investigation and discussion.

Future Directions

- Future studies in this field should consider examining the impacts of having multiple environmental stressors present in a child's life to further understand negative health outcomes and school readiness.
- Additional research on noise-exposure is necessary in order to establish the appropriate noise thresholds that are safe for children, and reduces noise exposure at the primary sources.
- Language and cognitive development in preschool period may be associated with family income. Children in families with a higher socioeconomic status are exposed to greater amounts of resources that aids language development, thus, results in more developed language skills (Scheele, Leseman, & Mayo, 2010). In the present study, it remains unclear to what extent family income or specific types of risk factors related to family income affect the young children, thus it remains a goal for future studies.

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