

A Strategic Research Initiative on Air Pollution Exposure in Child Care Settings

Introduction

According to the World Health Organization, more than 90% of the world's children breathe toxic air daily and one in every 10 deaths under the age of five are related to air pollution. Scientific studies have observed clear links between the amount of air pollution where a child resides and symptomatic or clinically relevant health outcomes.

These include reduced lung function, the onset of asthma and its severity, respiratory infections, cognitive impairment, reproductive development, and other morbidities.¹⁻⁸ Since children have higher breathing rates per body mass than adults, they absorb more pollutants and are more vulnerable to the negative effects of air pollution. In addition, children's immune systems are immature, and their brains and organ structures are still developing and contribute to their susceptibility.

Children are also closer to the ground where some pollutants may have peak levels.

Also, some social determinants such as residential or daycare proximity to pollutant sources may disproportionately affect disadvantaged populations. Studies indicate that if these environmental exposures are not addressed early in life, they can lead to reduced lung function and increased risk of respiratory disease later in life.⁹

Children's increased sensitivity to air pollution makes understanding their exposure during daily activities critical for protecting their health. However, daily personal air pollution exposure and early development of health impacts for children under the age of five have been difficult to assess for many reasons. Most currently available data on pollution exposure relies on

secondary sources. Other health impact data has been obtained using invasive test methods that are difficult to conduct with young children, so it is limited primarily to symptomatic children.

Chemical Insights Research Institute's research initiative working with Georgia State University's School of Public Health will address these research gaps using an integrated pollution exposure and health response sampling strategy. Since many children under the age of five spend a considerable amount of time in childcare centers outside of their home, this study will monitor air pollution in a variety of childcare settings while also collecting and analyzing easy to obtain biological samples that can be used to assess the early development of adverse health impacts from this exposure.



Childcare can be a significant contributor to daily air pollution exposure since the amount of time spent in the setting is considerable. In addition, childcare centers are typically geographically well-distributed in residential and commercial locations so a variety of settings representing different potential exposure levels can be studied.

Our research will use microsensors to collect air quality data that are as close to personal exposure levels as possible in young children. High resolution metabolomics will be used to evaluate saliva samples to assess changes in metabolic pathways that can indicate developing health impacts. Chemical characterization and toxicological assessment will also be done on representative pollutants. This integrated approach will provide beneficial insights into the relationship between air pollution exposure and disease etiology in young children. Furthermore, these results will inform mitigation strategies and the development of educational resources for minimizing adverse pollution exposures.

Study Objectives

- Quantify representative indoor and outdoor air pollution exposure in childcare centers that are site and season specific at defined locations and develop personal exposure metrics.
- Assess the chemical composition and toxicological impacts of the particulate matter pollutants children are exposed to in the representative childcare settings.
- Evaluate the mechanistic response to measured air pollution exposure by examining changes in the metabolomic profile of saliva samples.

Study Plan Overview

The study objectives will be achieved using the following sampling and assessment plan.

1. Childcare centers will serve as sampling sites. These sites will be selected to represent both near-road locations and far-from-road locations in a city with moderately high levels of background pollution.
2. Children ages three-four years who attend one of the childcare centers chosen as a study site will be selected as participants. To reduce selection bias, recruitment targets that represent the local area population in terms of sex, race, socioeconomic status, and baseline health status will be established.
3. At each childcare center, seasonal air sampling campaigns will be conducted for two years. One sampling campaign will occur during summer months (June–August) each year and the other during winter months (December–February).
4. Continuous indoor and outdoor air quality monitoring will occur during

Scientific Outcomes

01

Quantification of representative daily indoor and outdoor personal air pollution exposure for young children in childcare settings.

02

Chemical characterization of particulate matter air pollution present in childcare settings.

03

Toxicological assessment of particulate matter air pollution present in childcare settings.

04

Evaluation of metabolomic profiling of young children using saliva and its applicability to air pollution exposure.

05

Evaluation of the relationship between air pollution exposure and related disease etiology in young children.

Research Partners

Georgia State University,
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Emory University

- regular business hours at each childcare center. Measurements will include PM_{2.5} particulate black carbon, particle number concentration and size distribution, ozone, nitrogen oxides, temperature, and relative humidity. Outdoor stationary sampling at each location will measure ambient outdoor concentrations at each facility and reflect any between-location differences arising from proximity to pollution sources.
- Particulate samples will be used for chemical characterization and toxicological analysis.
 - Select participants per week from each site will participate in 24-hour, personal exposure monitoring using easily portable microsensors. This will allow the representative samples from the childcare centers to be put into the context of participants' everyday activities.
 - Exposure and characterization data derived from air quality monitoring will be analyzed and integrated with the results of the metabolomic profiling of saliva samples to inform an understanding of the health impacts of air pollution on children. This will also be used to investigate links to variables such as age, sex, race, and socioeconomic status via statistical analysis.

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