Student assessment of $PM_{2.5}$ concentration at ECU Transit bus stops using a low-cost aerosol monitor

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Background

- Exposure to $PM_{2.5}$ (particles 2.5 micrometers and smaller) or fine particulate matter, both short-term and long-term, is known to negatively affect the respiratory system.
- Individuals with existing respiratory conditions, such as asthma and chronic obstructive pulmonary disease (COPD), are especially vulnerable.
- A primary source of $PM_{2.5}$ is vehicle emissions, including those from cars, trucks, and buses.
- Most ECU Transit bus stops are in parking lots or alongside highways, placing student commuters at an increased risk of $PM_{2.5}$ exposure and subsequent negative health effects.

Objectives

- Measure the *personal exposure* of ECU Transit student commuters to $PM_{2.5}$ while waiting at bus stops around campus.
- Determine trends in students' personal exposure based on location of the bus stop and different day.

Methods

Personal Monitoring Devices

- Three (3) AirBeam 2 aerosol monitors
- Four (4) AirBeam 3 aerosol monitors
  - Both devices measure $PM_{2.5}$ as well as temperature and relative humidity

Reference Instruments

- Pitt County EPA Federal Reference Method (FRM) site, located at the Pitt County Agricultural Center
- ADR-1500 dust monitor, located at the intersection of Charles Boulevard and Greenville Boulevard

Participant Selection

- Seven ECU student participants were selected based on the frequency of their use the ECU Transit system. Participants were trained on proper use of the AirBeam and AirCasting software.

Field Deployment

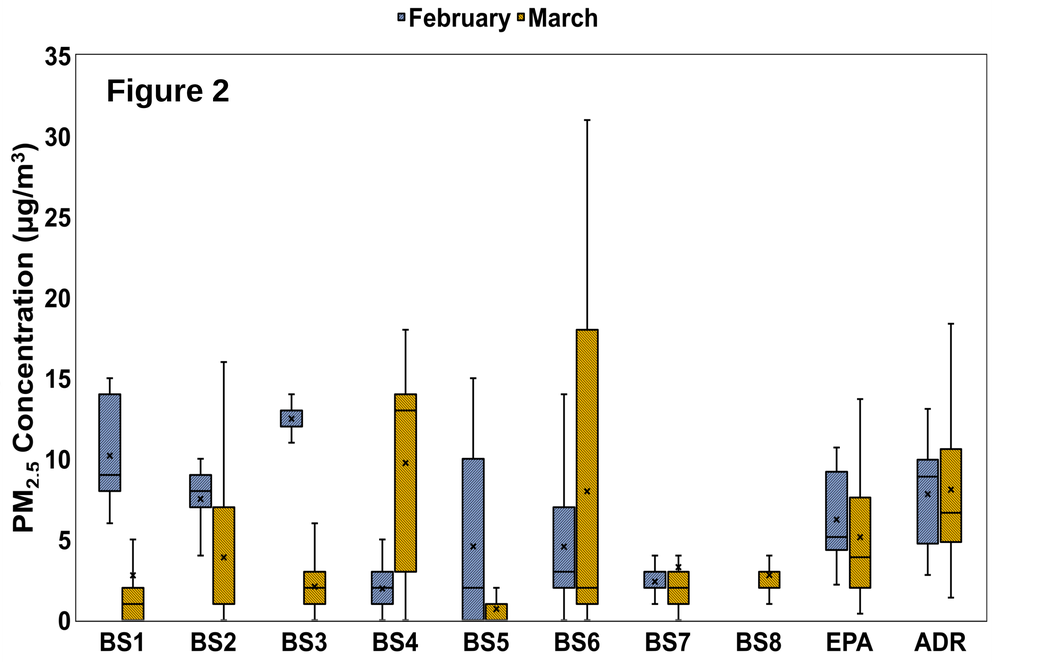
- Study period of four (4) weeks.
- Participants recorded ambient $PM_{2.5}$ concentrations in their personal breathing zones for the duration of their wait each time they waited at a bus stop.
- Recording data was transmitted daily.

Table 1: Participant Timelines.

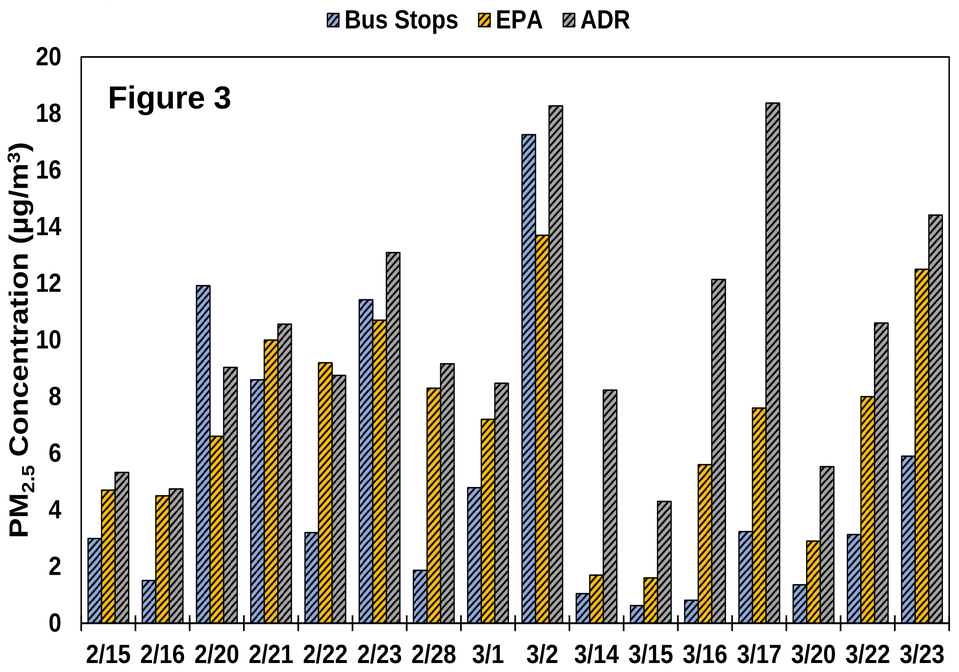
ID	Active Period	Active Now? Y/N
P1	2/15/23 - 3/16/23	N
P2	2/17/23 - 3/17/23	N
P3	2/27/23 - 3/27/23	N
P4	3/20/23 - 4/17/23	Y
P5	3/20/23 - 4/17/23	Y
P6	3/20/23 - 4/17/23	Y
P7	3/20/23 - 4/17/23	Y

Monitoring Setup

Results



- **Figure 2 displays $PM_{2.5}$ concentration data (µg/m³) per bus stop, as well as EPA and ADR-1500 concentration data, from both February and March.**



- **Figure 3 indicates $PM_{2.5}$ concentration data for each day that air quality measurements were recorded using the AirBeam monitors, shown alongside well as data from the Pitt County EPA FRM site and the ADR-1500 recorded on those days.**

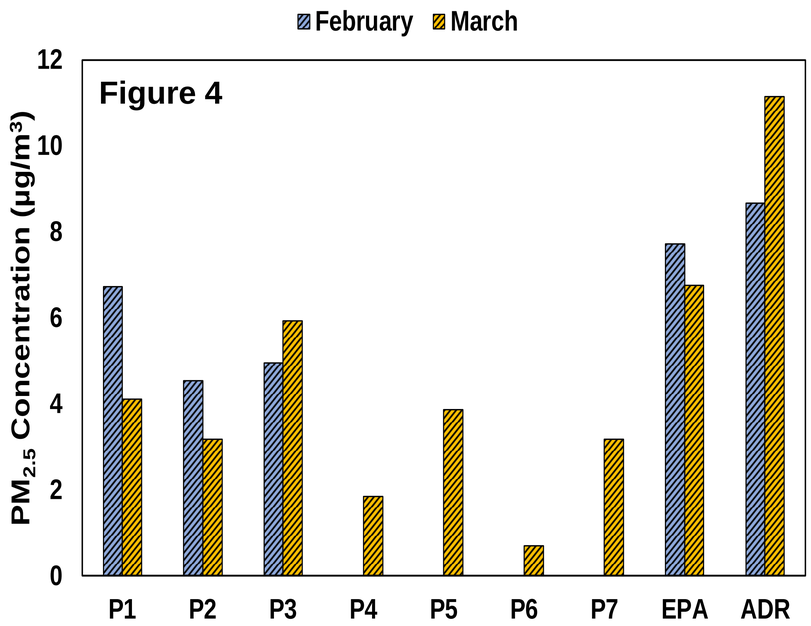


Figure 4: Mean $PM_{2.5}$ concentration exposures per participant by month, shown alongside mean $PM_{2.5}$ concentration data from the Pitt County EPA monitoring site and the ADR-1500.

Results

- The maximum and mean $PM_{2.5}$ concentration values recorded by participant AirBeam monitors *did not* exceed the maximum and mean concentration values recorded by the Pitt County EPA FRM site and the ADR-1500 *on a regular and consistent basis.*
- However, on multiple occasions, the maximum and/or mean $PM_{2.5}$ concentration values recorded by participant AirBeam monitors exceeded the maximum and mean concentration values recorded by the Pitt County EPA FRM site and the ADR-1500.
- In March, the mean $PM_{2.5}$ concentration from Bus Stop 4 and Bus Stop 6 exceeded the mean concentration values recorded by both the EPA FRM site and the ADR-1500.
- On 2/20, mean $PM_{2.5}$ concentration values recorded at bus stops exceeded concentration values recorded by both the Pitt County EPA FRM site and the ADR-1500.
- On 2/23 and 3/2, mean $PM_{2.5}$ concentration values recorded at bus stops exceeded concentration values recorded by the Pitt County EPA FRM site.
- None of the participants' mean personal exposures exceeded concentrations recorded by the EPA FRM site and the ADR-1500.

Conclusions

- The results indicate the possibility that students who use the ECU Transit bus system could be exposed to $PM_{2.5}$ concentrations higher than those measured by the EPA in Pitt County, North Carolina.
- The EPA $PM_{2.5}$ concentration limit is 35 µg/m3 over a 24-hour period. None of the measurements provided a $PM_{2.5}$ concentrations greater than the limit, indicating that ECU bus fleet produces an acceptable level of emissions.
- More research is necessary to determine the cause of differences in $PM_{2.5}$ concentration over time.
- Possible limitations include staggered participant start dates, using two different generations of the AirBeam aerosol monitor, participants' schedules.

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This study was approved by the East Carolina University and Medical Center Institutional Review Board (UMCIRB-000167).