

# AIR POLLUTANTS AND CHILDHOOD ASTHMA IN THE BRONX

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## Abstract

Children in New York City are two times more likely to be hospitalized for asthma than a child in the United States as a whole. The Bronx, in New York City, has the highest rates of childhood asthma than the rest of the city. Most of the cases of childhood asthma come from the South Bronx, which is also one of the lowest income areas of the city. Mott Haven and Hunts Point are two neighborhoods in the South Bronx that have the highest rates of childhood asthma in New York City. This research seeks to examine the air quality of The Bronx to see if the air near schools and playgrounds are affected by heavy traffic and to compare the air quality of lower income neighborhoods in the South Bronx with higher income neighborhoods, such as, Fieldston and Pelham Bay. To gather data of the air quality in the Bronx, four sensors were used to provide data on their respective air pollutants. Volatile organic compounds, carbon dioxide, particulate matter, and ultraviolet light measurements were taken at eight locations in The Bronx. After all the data was collected, an average for was taken for each pollution for the respective location. It was shown that all the South Bronx locations have higher levels of particle matter measurements than the more affluent neighborhoods: Fieldston and Pelham Bay. Mott Haven, neighborhood with high rates of asthma, has the highest number of VOCs measured. The research shows that heavy traffic does have an impact on the air quality of the playgrounds in which children in the South Bronx play. If the rates of asthma in those same neighborhoods are considered, it also affects the health of the children as well.

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## Introduction

Asthma is a respiratory condition that affects more than 25 million Americans nationwide.<sup>1</sup> In an asthma attack, one's airways begin to narrow and contract and become filled with mucus. This makes it difficult for the individual to breathe and can be fatal if not treated quickly. Asthma attacks often are triggered by different environmental factors in the air that get into one's lungs. Asthma is the leading chronic disease in children.<sup>2</sup>

In 2000, children in New York City were almost twice as likely to be hospitalized for asthma than children in the United States as a whole.<sup>3</sup> Asthma is widespread and a major issue in New York City, and has gained the attention of NYC Department of Health. There must be environmental factors in NYC that is causing such a large asthma prevalence. This not just a major problem in New York City. Many cities across the United States have higher rates of asthma compared to more rural or suburban areas of the country. Urban areas are hot spots for asthma and other respiratory conditions.

The Bronx is out of the five boroughs that make up New York City. The Bronx currently has the highest rates of childhood asthma in all of New York City as shown in Figure 1. The highest rates of childhood asthma are in the South Bronx, which are also some of the lowest income areas of the borough. The areas with the lowest income, also have the most asthma diagnoses and asthma hospitalization rates. The two neighborhoods which suffer the most rates of childhood asthma are Mott Haven and Hunts Point. As seen in figure 1, the neighborhoods of Mott Haven and Hunts Point have the darkest color. Children from ages 0-12 in those neighborhoods have been hospitalized from 73-119 children per 100,000 in 2014. In the Bronx, 17.4% of children up to 12 years old have been diagnosed with asthma. Asthma related ER visits for groups aged from 5-14 in 2014 has increased by 39% at a rate of 483 per 10,000. Bronx asthma rates have stayed almost stable, while every

other borough has seen a decrease in asthma hospitalizations as seen in Figure 2.

Minorities and people of lower income/below the poverty line seem to be the most susceptible to being hospitalized due to asthma compared to those of higher income. The Bronx has the lowest median household income according to the U.S. census bureau. According to data from NYU Furman Center, the medium household income of Mott Haven in 2017 was \$21,366, that is 66% less than the median income of New York City, which is \$62,040. 44.2% of people living in Mott Haven live below the poverty line. Mott Haven has similar demographics as Mott Haven. More affluent

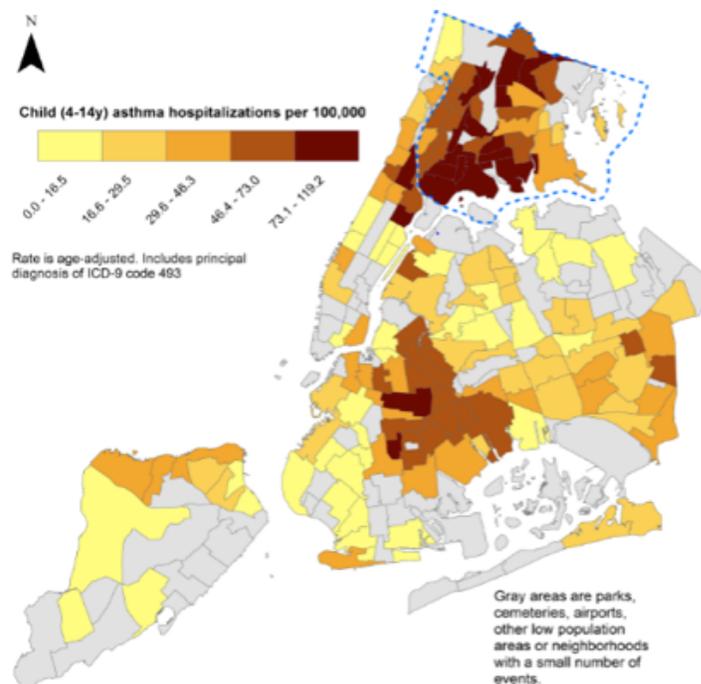
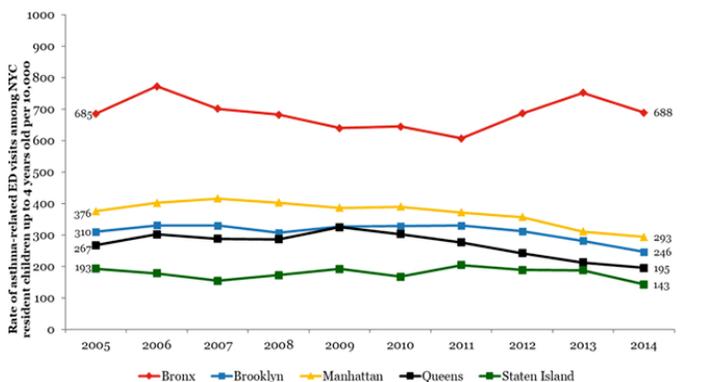


Figure 1: Map of Childhood Asthma Rates in NYC

neighborhoods, such as Fieldston, Riverdale, have less people in poverty and higher median incomes. The average medium income of Fieldston, based on the 2017 American Community Survey, is \$80,932, and has significantly lower rates of asthma hospitalizations than the South Bronx.

The South Bronx is often nicknamed “island of pollution” by residents who live there.<sup>4</sup> The South Bronx is surrounded by three major highways: Major Deegan, Bruckner, and Cross Bronx expressways. Many public schools and playgrounds in the South Bronx are in very close proximity or across the street from these major highways. The times student leave school or go to the playgrounds after school, is the time traffic started to become the heaviest due to rush hour approaching. Children in the South Bronx after school are exposed to emissions from heavy traffic. Also, the two neighborhoods mentioned previously with the highest rates of asthma, Hunts Point and Mott Haven, are the more industrialized neighborhoods in the borough. Hunts Point has the Hunts Point Produce Market which bring 15,000 diesel semitrucks driving through the neighborhood to deliver food and contributes greatly to traffic congestion.<sup>5</sup> Mott Haven has the Port Morris and many other sewage plants for the department of sanitation. The new fresh direct building in Mott Haven also brings in about 1000 fresh direct diesel semi-trucks through Mott Haven.

Many air pollutants are emitted from the exhaust of gas fueled vehicles, especially diesel trucks. Fossil fuel powered vehicles release CO<sub>2</sub>, volatile organic compounds (VOCs), and nitrous oxides (NO<sub>x</sub>) into the air. During summer when the most UV radiation is received; the VOCs and NO<sub>x</sub> start to react together under intense heat and sunlight. The product of that reaction is ground level ozone. Ground level ozone is toxic, and colorless gas that is harmful to humans in high concentrations. According to the EPA, breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and airway inflammation. It also can reduce lung function and harm lung tissue. Sensitive groups such as, people with asthma, children, and the elderly are the most at risk from breathing air with ozone. Particulate matter (PM) is another pollutant that is emitted from vehicles. Particulate matter, according to the EPA, are microscopic solids/dust particles or liquid droplets that are so small they can be inhaled and cause serious health problems. PM smaller than 2.5 micrometers in diameter is the most dangerous. PM of that size can go the deepest into your lungs and even your bloodstream. It can cause many respiratory issue and even cancer with long term exposure.



Bronx Community Health Dashboard - Montefiore Hospital

Figure 2: ED Visits of Children up to age 4

The South Bronx provides an ideal context in which to investigate the effects of traffic-related air pollution on children with asthma, because large numbers of children with asthma live and attend schools or play in playgrounds near highways that experience heavy traffic with trucks and cars. This research is intended to survey the air quality of different Bronx neighborhoods, and to compare the air quality of lower income neighborhoods and higher income neighborhoods. Lastly, to see if areas with poor air quality high rates of childhood asthma have, using data from New York City DOHMH Environment & Health Data Portal and if heavy traffic does have an impact on air quality.

## Methods & Materials

Eight sites, in different neighborhoods in the Bronx were chosen for air quality measurements. The eight sites' location can be seen in Figure 3. The lower income, and South Bronx locations chosen were, Millbrook Playground in Mott Haven, 134 Playground in Mott Haven, Lyons Square Playground in hunts Point, Prospect Playground and Tremont Park in Tremont, and Noble Playground in West Farms. The uptown Bronx locations, or more affluent areas chosen were Horace Mann School in Fieldston, Pelham Bay Park, and Van Cortlandt Park. All South Bronx locations were strategically chosen to be a playground or school in very close proximity to a highway, in order to assess the effects of heavy traffic on the air quality in areas that children and see a link with childhood asthma.

Air measurements were obtained using four different air pollutant sensors manufactured by the company Adafruit. The open source programming software, Arduino, was used to help



Figure 3: Map of Site Locations in The Bronx

program and calibrate the sensors acquired for measurements. The sensors were calibrated and assembled with help from the physics department. The sensors collected the measurements and the data is processed through the Arduino board and stored on a data logger with an SD card. A sensor to detect levels of ozone in ppb and ppm was used. A sensor that measured volatile organic compounds (VOCs) in ppb and CO<sub>2</sub> in ppm. A sensor that measured particulate matter (PM) in several different sizes: 0.3µm, 0.5µm, 1µm, 2.5µm, 5µm, 50µm. The PM sensor used can be seen in Figure 4. The particulate matter sensor works by counting the amount of particulate in each size respectively in 0.1 L of air. Table 1 shows an example of how the sensor categorizes it's data on excel using the Arduino system. Lastly, a sensor for UV was used, which provided the amount of UVA, UVB, and UV index by measuring the µW/cm<sup>2</sup>.

Each location was visited twice a week from June 12<sup>th</sup> to August 12<sup>th</sup>. The locations were visit at similar times from 3:00pm-4:00pm to measure the air when rush hour is about the begin and traffic starts becoming heavy. Fieldston, Van Cortlandt Park, Hunts Point, and Pelham Bay Park were taken every Monday and

Wednesday. Mott Haven Locations, Prospect Playground. Noble Playground, and Tremont park were taken Tuesday and Thursdays. Fridays the location sets would be alternated every week. Air measurements were taken by placing the sensors down in a secure place at the respected location, then switch them on. After the measurements were collected and data stored on the SD card, and all the data points were averaged on excel as shown in figure 2 for that respective day. After the data collection of the whole summer was complete, an average was taken of all the daily averages to provide a summer wide average from June-August.

### Results

After the end of the research, the VOC and PM measurements provided data that was close to previous assumptions. South Bronx locations had high levels of PM and Mott Haven had the highest number of VOCs out of all the neighborhoods. The results are bar charts based on the final average of all the data at the end of the research.

Figure 5 shows the measurements of VOCs in parts per billion (PPB) and CO<sub>2</sub> in parts per million (PPM). The highest VOC measured was in the Mott Haven neighborhood with an average of 1540.745 PPB from June 12<sup>th</sup> -August 12<sup>th</sup>. Mott Haven was one of the neighborhoods with the highest rates of childhood asthma hospitalizations. Fieldston, which is one of the affluent neighborhoods, has the second highest VOC measurement with an average of 921.529 PPB. The CO<sub>2</sub> measured is approximately 400 PPM in all neighborhoods.

Figure 6 shows the average amount of ozone measured during

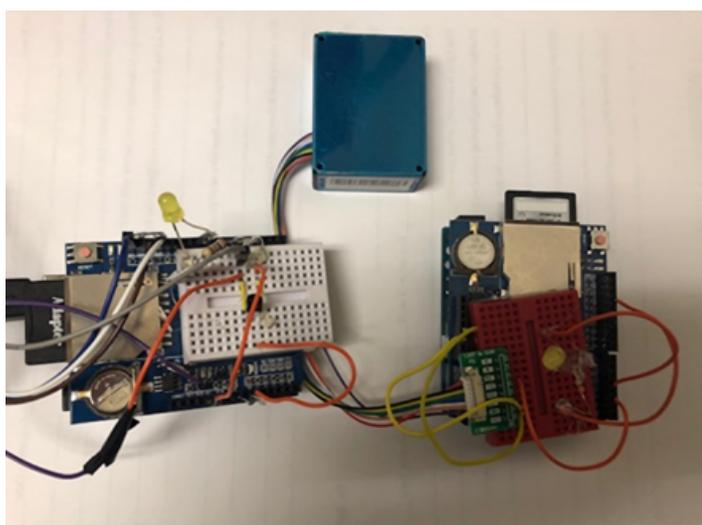


Figure 4: Particulate Matter Sensor

|    | A        | B        | C       | D         | E       | F        |
|----|----------|----------|---------|-----------|---------|----------|
| 1  | .3µm/.1L | .5µm/.1L | 1µm/.1L | 2.5µm/.1L | 5µm/.1L | 50µm/.1L |
| 2  | 4644     | 1465     | 304     | 14        | 2       | 0        |
| 3  | 4545     | 1445     | 304     | 16        | 2       | 0        |
| 4  | 3327     | 1041     | 245     | 14        | 4       | 0        |
| 5  | 3408     | 1063     | 243     | 14        | 4       | 0        |
| 6  | 3180     | 981      | 187     | 16        | 0       | 0        |
| 7  | 2901     | 895      | 182     | 16        | 0       | 0        |
| 8  | 3174     | 1003     | 199     | 6         | 0       | 0        |
| 9  | 3174     | 1003     | 199     | 6         | 0       | 0        |
| 10 | 3660     | 1154     | 221     | 4         | 0       | 0        |
| 11 | 3660     | 1154     | 221     | 4         | 0       | 0        |
| 12 | Date     |          |         |           |         |          |
| 13 | 2019     | 7        | 17      | 15        | 13      |          |
| 14 | average  |          |         |           |         |          |
| 15 | 3567.3   | 1120.4   | 230.5   | 11        | 1.2     | 0        |

Table 1: PM Measurements of Hunts Point on 07/17/2019

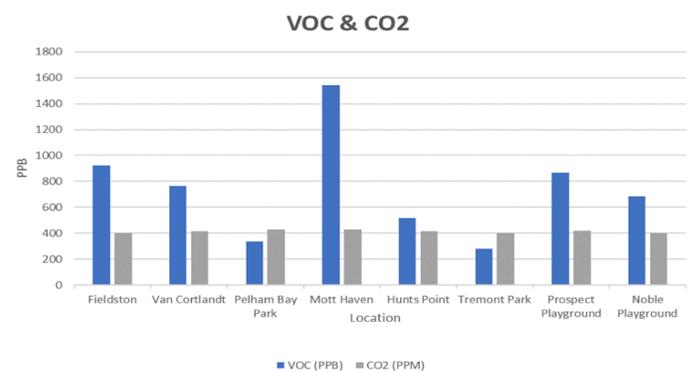


Figure 5: VOC & CO<sub>2</sub> Measurements

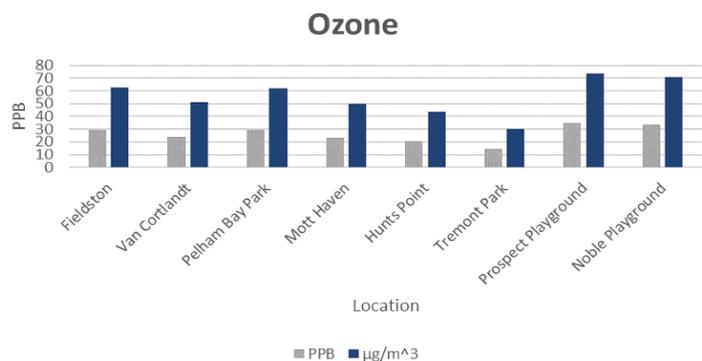


Figure 6: Ozone Measurements

the summer in PPB. The ozone measurements were generally low across all the neighborhoods. EPA standards for exposure to ozone for more than 8 hours is less than 70 PPB. Every neighborhood measured has ozone levels well below 70 PPB. Though Prospect Playground and Noble playground have the highest average ozone measured, it is not passing the EPA limit.

Figure 7 shows the number of particles measured in three different sizes/diameter. The sensor measured PM in .3, .5, and 1 micrometer. The sensor counts the number of particles for the respective size in .1 liters of air. The data shows that all the South Bronx (lower income areas) have high amounts of PM in the air than Fieldston and Pelham Bay Park (Wealthier areas). Van Cortlandt park also has high levels of PM in the air as well, which was unexpected.

Figure 8 shows the amount UVA and UVB rays averaged over the summer. UV rays are expected to be high since it is summer. Neighborhoods with lower UV levels are due to the measurement location being in shade due to tree coverage. High UV radiation in heavy traffic conditions can lead to the formation of ground level ozone.

## Conclusion

The South Bronx in New York City has neighborhoods with many people below the poverty line and on public assistance. These same neighborhoods also have some of the highest rates of asthma in the city. The New York City health department considers

indoor air quality as one of the main reasons of asthma in children. Though indoor air quality does have an effect on respiratory health, outdoor air quality should be a factor that gets more attention and research as well. Since this epidemic is affecting mostly individuals of lower income, there environmental injustice evident in New York City.

The data in the results section does support the initial assumption that the South Bronx has lower air quality than their wealthier counterparts. This is evident by the PM measurements in figure 8. PM, as previously mentioned, can be very dangerous if inhaled for long periods of time. All the South Bronx locations had high PM levels close to 2000 particles in .1 L of air. During the research, the PM ratings would be consistently high, unlike Fieldston or Pelham Bay whose measurements were never constantly high. In the future, a different type of statistical analysis of the data will be used to not have one day of random spiked data skew the averaged too heavily. Van Cortlandt Park measurements were surprising, because the PM levels were not expected to be so high. Initial possible reason for the high PM levels was that it is a park, so particles from the soil or vegetation may be the cause. Pelham Bay Park is a large park system such as Van Cortlandt, but the PM measurements are much lower for reasons that are unclear and more research is required. Fall 2019 semester this research is being continued in Van Cortlandt park to have a better sense and understanding of the air quality in the park system.

The data in the research shows that heavy traffic is affecting the air quality in many neighborhoods. This can be seen in the high levels of PM over the Bronx and the high VOC levels in Mott Haven. It is evident that there is an issue with these pollutants, and it is affecting the health of children and the people living in these neighborhoods. The asthma data shows that there the health of the individuals living there are affected.

Possible solutions to this problem can be simply, planting more trees to provide vegetative barriers between children in the parks. Comparing Hunts Point and Mott Haven, neighborhoods with highest asthma rates, VOC levels provide an example of this. The playground at Hunts Point, is surrounded by a barrier of bushes and trees. Hunts Point had low VOC levels, despite heavy truck traffic driving on the Bruckner daily. The playground at Mott Haven, had little to know vegetative barrier between the highway and the park, and the VOC levels were the highest of all the neighborhoods. More research will be required test of this assumption is true, but the planting of trees is an initiative being developed by the city to improve air quality. Another possible aid to combat air pollution is the adafruit sensors and Arduino systems. These systems are cheap, affordable and easy to use. This can provide residents with sensors that give them information of the air quality at their exactly location. This type of information can help provide people in the neighborhoods enough information to take required actions for their health and provide people with an awareness of the air they are breathing.

## References

1. CDC.gov. (2018). CDC - Asthma - Data and Surveillance - Asthma Surveillance Data. [online] Available at: <http://www.cdc.gov/asthma/asthmadata.htm>.

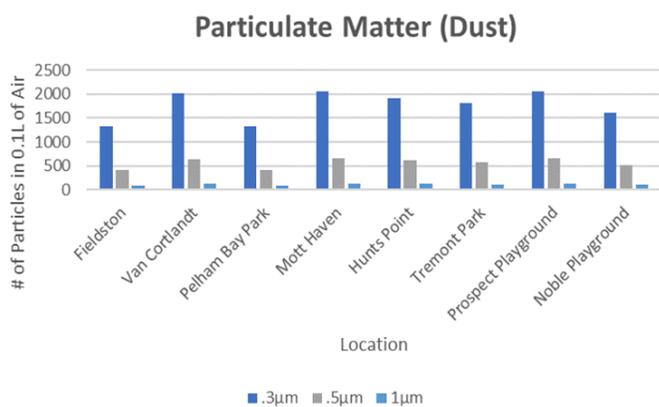


Figure 7: PM Measurements

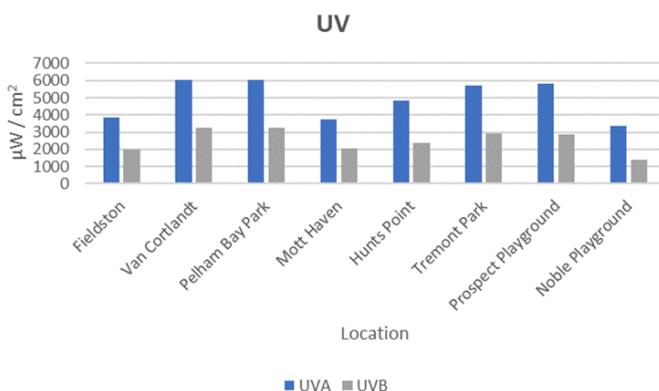


Figure 8: UV Measurements

2. CDC.gov. (2018). Asthma | Healthy Schools | CDC. [online] Available at: <https://www.cdc.gov/healthyschools/asthma>.
3. Garg R.; Karpati A.; Leighton J.; Perrin M.; Shah M. *Asthma Facts*, New York City Department of Health and Mental Hygiene, *Second Edition*, **2003**, 10-11.
4. Butini, C. (2018, January 30). Asthma By The Numbers. Retrieved October 4, 2019, from <https://medium.com/asthma-in-the-south-bronx/asthma-by-the-numbers-73553b2c9621>.
5. Yahalom S.; Johansson E.; Guan C.; Kamga C., *Hunts Point Terminal Market: The Demand for Waterborne Transportation as a Part of the Outbound-Distribution System*, **2017**, 3-4.