Exploring Exposure to Particulate Matter 2.5 and NO^2 as Potential Factors Influencing Neonatal Deaths and Fertility Rates

Lizbeth Gomez
Columbia University Mailman School of Public Health

COLUMBIA | MAILMAN SCHOOL OF PUBLIC HEALTH

COLUMBIA | MAILMAN SCHOOL OF PUBLIC HEALTH
ENVIRONMENTAL HEALTH SCIENCES

Background

Traffic-related air pollution has been linked to multiple adverse pregnancy outcomes that range from birth defects to spontaneous abortions. More recently a few studies have looked at the rates of fertility among reproductively active women as result of exposure to traffic related air pollution.

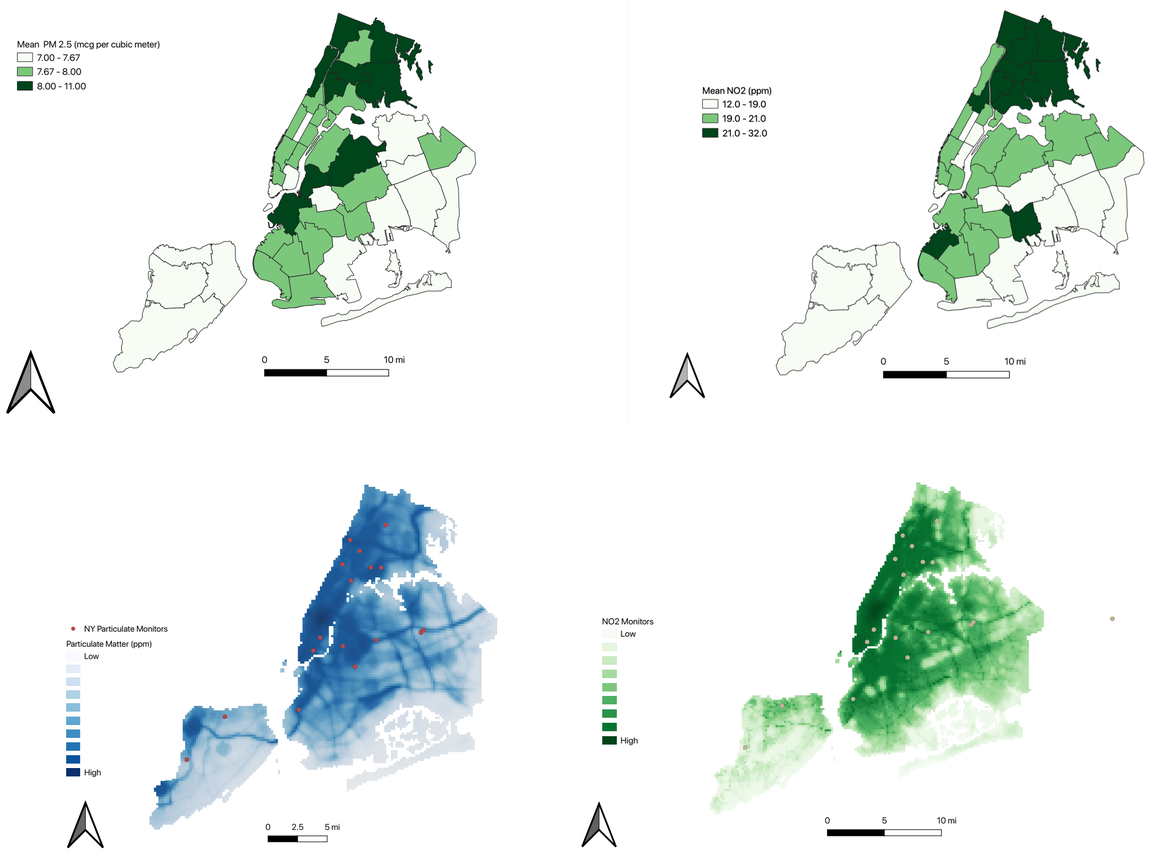
These studies have estimated adverse reproductive effects of exposure to air pollution that include reduced birth weight, preterm birth, and small for gestational age birth-weight These reproductive endpoints are relatively easy to measure and thus lend themselves to more feasible analyses of exposure-related effects.

New York City's air contains particles, liquid droplets, gases, and other contaminants that could impact health. Two pollutants, particulate matter and nitrogen dioxide, are of health concern since New York City's air does not currently meet federal air quality standards.

Objectives

In the present analysis we aim to identify neighborhood level exposure factors, such as Particulate Matter 2.5 and Nitrogen Dioxide as potential predictors of neonatal death and fertility rates among united hospital fund neighborhoods.

Images 1A and 1B. Annual Mean Observation and interpolation of PM 2.5 and NO^2 exposure by UHF neighborhood.



Methods and Materials

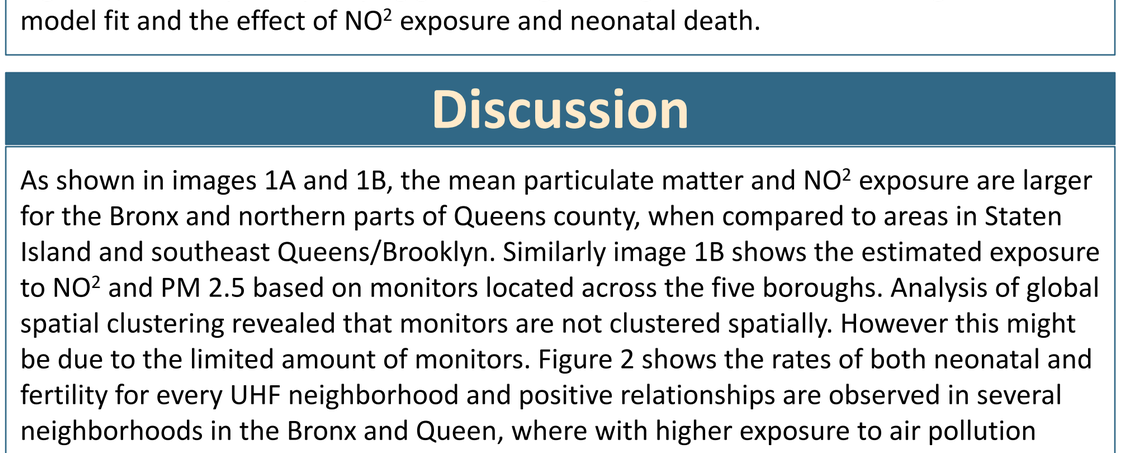
This analysis used descriptive geographical visualization method to identify if there is an overlap of NO^2 and PM 2.5 within the five boroughs that makeup NYC.
I used data from the environment and health data portal to overlay traffic related air pollution data per each neighborhood within NYC, as well as the two health outcomes in question here: Neonatal deaths and fertility rates. Then I used geostatistical interpolation to analyze and predict the spatiotemporal association between these variables. Lastly, I used the geographical weighted regression (GWR) tool to look at spatially varying local regressions of both NO^2 exposure and neonatal death.

Table 1. Annual Mean Observation for air pollution exposure and health outcomes by county

	Bronx	Staten Island	Manhattan	Brooklyn	Queens
PM 2.5 (mgc/c^3)	7.7	6.8	8.7	7.5	7.2
NO^2 (ppb)	19.4	13.4	24.6	18.5	17.9
Neonatal Deaths (per 1k live births)	4.0	3.4	2.3	2.4	2.9
Fertility Rates (per 1k women)	1999.8	1449.2	1833.2	2105.7	1616.7

Map Results

Image 2. Fertility and neonatal death

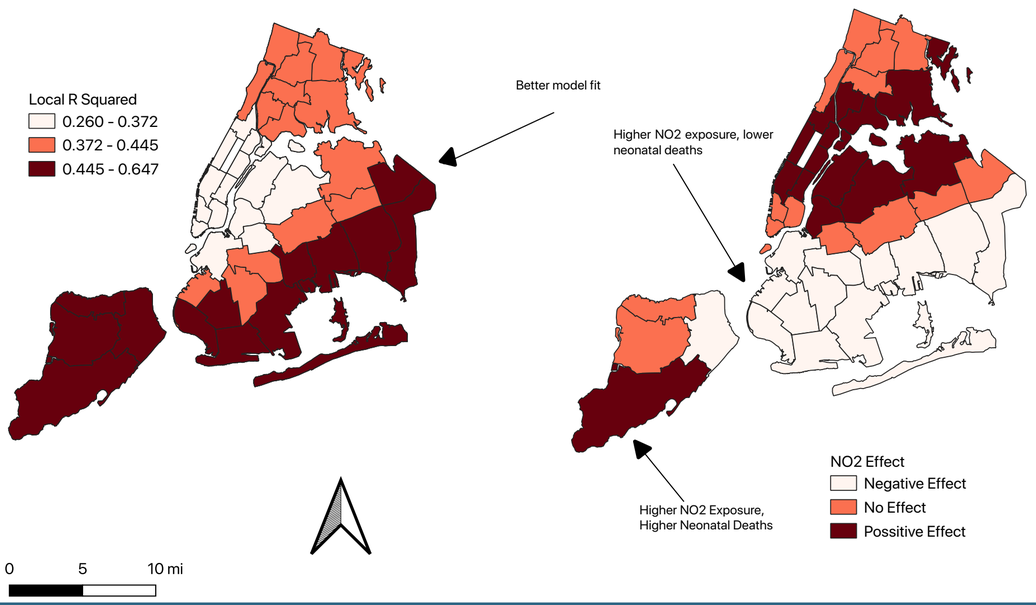


Mean observation (Image 1A) of the particulate matter and nitrogen dioxide exposure per neighborhood defined by United Hospital Fund boundaries. Interpolation of both exposures according to total counts for emissions are shown in image 1B.
Table 1 summarizes the mean observations for both exposure and outcome variables seen in all five boroughs within NYC.
Image 2, shows the rates of neonatal deaths and fertility for each neighborhood defined by the United Hospital Fund boundaries.
Figure 3, shows spatially varying global weighted regression results of the significant model fit and the effect of NO^2 exposure and neonatal death.

Discussion

As shown in images 1A and 1B, the mean particulate matter and NO^2 exposure are larger for the Bronx and northern parts of Queens county, when compared to areas in Staten Island and southeast Queens/Brooklyn. Similarly image 1B shows the estimated exposure to NO^2 and PM 2.5 based on monitors located across the five boroughs. Analysis of global spatial clustering revealed that monitors are not clustered spatially. However this might be due to the limited amount of monitors. Figure 2 shows the rates of both neonatal and fertility for every UHF neighborhood and positive relationships are observed in several neighborhoods in the Bronx and Queen, where with higher exposure to air pollution there is higher rates of neonatal deaths. Fertility is also seen to be decreased in areas with increased air pollution levels. Upon weighted regression analysis using GeoDa, neonatal deaths and NO^2 exposure were shown to be significantly relates (Moran's I = 0.39), therefore in order to look at the spatial variation results and model fit, I used R software to run GRW analysis and the results are shown in image 3.

Image 3. spatially varying GWR results for model fit and effect of NO^2 exposure and neonatal deaths.



Conclusions and Future Studies

These results show that there is a significant relationship between NO^2 and neonatal deaths in UHF neighborhoods across all five boroughs in NYC. Particulate Matter size 2.5ug was also seen to be a factor for increased deaths and decreased futility when maps were overlaid. This finding is important in showing the devastating effects that traffic related air pollution can have in NYC residents, especially in sensitive groups and female reproductive system. New York City's air does not currently meet federal air quality standards, and though it has improved significantly over the past two decades, there is a need for evidence-based regulatory policy.

For future studies, I plan to conduct a more thorough analysis; one which includes socio-economic characteristics as covariates.

References

1. Leiser CL, Hanson HA, Sawyer K, et al. Acute effects of air pollutants on spontaneous pregnancy loss: a case-crossover study. Fertil Steril. 2019;111(2):341-347. doi:10.1016/j.fertnstert.2018.10.028
2. Gaskins AJ, Hart JE, Chavarro JE, et al. Air pollution exposure and risk of spontaneous abortion in the Nurses' Health Study II. Hum Reprod. 2019;34(9):1809-1817. doi:10.1093/humrep/dez111
3. Forns J, Sunyer J, Garcia-Esteban R, et al. Air Pollution Exposure During Pregnancy and Symptoms of Attention Deficit and Hyperactivity Disorder in Children in Europe. Epidemiology. 2018;29(5):618-626. doi:10.1097/EDE.0000000000000874
4. Ambient Air Pollution Exposure and Fecundability in Women Undergoing In Vitro Fertilization. - PubMed - NCBI. https://www.ncbi.nlm.nih.gov/pubmed/31214664. Accessed October 29, 2019
5. Kioumourtzoglou M-A, Raz R, Wilson A, et al. Traffic-related Air Pollution and Pregnancy Loss. Epidemiology. 2019;30(1):4-10. doi:10.1097/EDE.0000000000000918
6. http://a816-dohbesp.nyc.gov/IndicatorPublic/PublicTracking.aspx