ASTHMA STUDY

A response to Budget Article VII, 2018-2019 SFY

Developed by the New York State Department of Health with Contributions
from the New York City Department of Health and Mental Hygiene

Released January 2023

Executive Summary

Overview

This report was compiled in response to Article VII, Part MM in the SFY 2018-2019 State budget, which directed the New York State (NYS) Department of Health (the Department) to prepare a study of, and recommendations for, evidence-based interventions (EBIs) to address the high burden of asthma in the boroughs of Brooklyn and Manhattan. The report was developed by the Department's Office of Public Health with contributions from the New York City (NYC) Department of Health and Mental Hygiene (DOHMH). The Department convened a working group consisting of various stakeholders (e.g., governmental and academic professionals, and community-based organizations (CBOs)) to provide technical input, review, and feedback on report scope, content, and timeline. Based on iterative feedback and participation from the working group, collective decisions were made to 1) consider all five boroughs of NYC to ensure responsiveness to areas experiencing the highest burden of asthma, and 2) to use only existing data previously collected by NYC and NYS agencies due to limited time and resources dedicated for this project. The following report provides: 1) an overview of the burden of asthma statewide and in NYC neighborhoods; 2) a review of high-risk neighborhoods disproportionately impacted by asthma; 3) a review of the indoor and outdoor environmental triggers and allergens, and outdoor air quality; and 4) evidence-based and best practice recommendations for policies, strategies, and interventions supportive of asthma control.

The Problem

In NYS the burden of asthma continues to be a major public health problem. Particularly in NYC, rates for major asthma burden indicators have consistently trended higher than NYS overall. Asthma is a chronic disease of the lungs that causes wheezing, breathlessness, chest tightness, and coughing, and when not well controlled can greatly diminish quality of life and result in avoidable morbidity and mortality. While both adults and children can suffer from asthma, it is one of the most common chronic diseases among children. The burden of childhood asthma not only affects the child, but also their caregivers and families in terms of missed school and workdays due to asthma and other impacts on quality of life.

Asthma is a multifactorial disease and both genetic and environmental factors can affect its incidence. The exact cause of asthma is unknown, however both indoor (e.g., nitrogen dioxide emissions from unvented natural-gas appliances; tobacco smoke; allergens from pets, dust mites, rodents, and cockroaches; irritant chemicals, pollen and mold; and dampness) and outdoor environmental sources (e.g., ozone, sulfur dioxide, fine particles, and weather or seasonal impacts) contribute to the development and exacerbation of asthma. Asthma burden is measured and described by aspects such as those who have received a diagnosis of asthma, the prevalence of asthma episodes or attacks, asthma-related emergency department (ED) visits and hospitalizations, missed school/workdays due to asthma, and deaths due to asthma.

The burden of asthma falls disproportionately among specific demographic groups, specifically for persons and communities of color, where asthma prevalence is higher among Black, American Indian, and multiracial New Yorkers. Morbidity and mortality rates for asthma are higher for racial minorities, younger age groups, and those of lower socio-economic status (SES). Stark inequities in asthma-related health outcomes persist including higher rates of ED visits, hospitalizations, and deaths. Disparities and inequities can be attributed to economic, social, and cultural factors. For example, individuals may experience housing and/or work-related conditions that place them at greater risk for exposure to environmental allergens and irritants that can lead to or exacerbate asthma. Populations with lower SES are more likely to live in neighborhoods with sub-standard housing conditions, resulting in increased exposure to common asthma triggers such as cockroaches, mice, other pests, and poor building conditions, including leaks and mold. Beyond environmental triggers, asthma morbidity and mortality rates are correlated with income and insurance coverage, which may impact healthcare quality, access, and health outcomes that lead to asthma-related disparities and inequities.

Scope and Key Findings

The report responds to the legislation request across two sections as follows:

Part I: Asthma Burden, Data Review, and Trends

Asthma Burden and Socio-Demographic Disparities
Surveillance data on the burden of asthma in the US, NYS, and NYC is presented. Asthma prevalence statewide, citywide, and for each borough were obtained from the Behavioral Risk Factor Surveillance System (BRFSS) Survey. Prevalence rates were determined for children (0-17 years) and adults (18 years and older) as well as among school-age children (5-14 years). Asthma hospitalization and ED visit data were obtained from the NYS Statewide Planning and Research Cooperative System (SPARCS) to calculate crude and age-adjusted ED visit rates for asthma. Age-adjusted asthma mortality rates were calculated with data obtained from the NYS Vital Statistics. Disparities in asthma exacerbations were evaluated using asthma ED visit rates and BRFSS data to examine various socio-demographic factors including gender, race, education level, and income. Prevalence rates for both adults and children in NYC were compared within these socio-demographic categories. Data from the American Community Survey (ACS) were used to define low-income and non-low-income ZIP Codes.

Key Findings:

- Statewide asthma ED visit rates for both children and adults rose from 2005 until 2012, and then declined through 2014. In NYC, compared to other boroughs, the Bronx had the highest ED visit rate and has experienced rising rates in recent years. Brooklyn, Queens, and Staten Island had rates lower than NYC but higher than NYS excluding NYC.
- Hospitalizations due to asthma have decreased for both children and adults, but similar to the trend in ED visits, asthma hospitalization rates for children are higher than adults.
- United Hospital Fund (UHF)-42 neighborhoods reveal significant variation with neighborhoods in the Bronx, having the highest asthma ED visit rates. Children in the

Bronx consistently had the highest rate compared to the other NYC boroughs. Variation in the age-adjusted rate of adults reporting an asthma attack in the past year was seen across the five boroughs with the Bronx having higher rates than the other boroughs and NYC overall.

- The age-adjusted asthma mortality rate for NYC is higher than NYS with the Bronx showing a substantially higher mortality rate than other NYC boroughs.
- Asthma diagnoses among NYC school children reported through BRFSS showed increasing trends.
- Low-income ZIP codes and Black non-Hispanics consistently had higher asthma ED visit rates than comparison categories within the same county, while differences by sex were smaller and not consistent. Asthma ED visit rates in low-income ZIP codes were highest in the Bronx, followed by Manhattan while rates for Black non-Hispanic New Yorkers were highest in Manhattan followed by the Bronx. For both men and women, rates were highest in the Bronx. Patterns in sociodemographic disparities were similar among children for income and race/ethnicity.

Indoor Environmental Triggers and Allergens

Indoor environmental triggers for asthma were evaluated using NYC Housing and Vacancy Survey (NYCHVS), and the NYC Community Health Survey data collected by NYC agencies. This information is publicly available in the "Asthma and the Environment" dataset maintained by the NYC DOHMH. Data on housing characteristics, including maintenance deficiencies (leaks, dampness, structural damage), pest sightings (cockroaches, rodents), reports of indoor mold, and secondhand smoke (SHS) exposure were summarized for this report in the forms of percentages for each UHF-42 neighborhood. Commercial pesticide applications data from the Pesticide Sales and Use Reporting (PSUR) website were used to calculate number of applications. Age-adjusted rates of asthma ED visits in these neighborhoods were plotted against exposure estimates to look for correlation. Information on public housing distribution and population was obtained from the NYC Housing Authority (NYCHA) Resident Data Files. Using SPARCS data and NYCHA shapefiles, asthma rates in public housing were compared to rates outside of public housing.

Key Findings:

- Neighborhoods with highest percentage of households reporting leaks were in the Bronx and lowest in Staten Island. The highest percentage of reports among adults on presence of mold in at least one room in their buildings (excluding the bathroom) in the past 30 days, was also in the Bronx.
- About 15% of homes citywide reported three or more deficiencies in their homes including heating equipment breakdown, need for heating, cracks/holes in the walls, ceilings or floors, broken plaster/peeling paint and toilet breakdowns. The highest percent of homes with 3 or more maintenance deficiencies were reported in the Bronx while the lowest percentage was reported in Staten Island.

- Neighborhoods with the highest percentages of homes with daily cockroach sightings and with mouse sightings tended to be in the Bronx, while the lowest percentage was in Staten Island and some neighborhoods in eastern Queens.
- Percentage of households reporting any of the above (leaks, mold, maintenance deficiencies, pest sighting, rodent sighting) showed positive correlations with ED visit asthma rates, indicating that UHF-42 neighborhoods reporting a higher percentage of these exposures tend to have higher asthma ED visits among youth and adults.
- In terms of pesticide application, results of PSUR database queries showed that, in general, the UHF areas with the highest use of commercially applied pesticides containing asthma triggers like Piperonyl butoxide do not tend to be the same areas where asthma rates are highest.
- The presence of SHS was reported by about 5% of adults citywide. Neighborhoods in Queens reported the highest percent of adults reporting SHS. UHF-42 neighborhoods with a higher percent of youths and adults reporting SHS were observed to have a higher rate of asthma ED visits.
- About 5% of the total NYC population live in NYCHA developments including Section 8 Transition and Public Housing Units. UHF-42 neighborhoods with a higher proportion of population living in public housing were observed to have higher asthma ED visit rates, though this correlation cannot be specifically attributed to living in public housing.

Outdoor Air Quality, Triggers and Allergens

Outdoor air quality was evaluated by using 1) ambient air monitoring data (NYS Department of Environmental Conservation (DEC)); 2) number of registered permitted facilities per square mile (NYS DEC); and 3) traffic counts from monitoring locations (NYS Department of Transportation (DOT)). Trends of annual mean temperature and precipitation were observed using National Oceanic and Atmospheric Administration's (NOAA) historical meteorological data for Central Park. 2010-2018 Pollen data from the National Allergy Bureau (NAB) pollen monitoring station at Lincoln Center were used to calculate average monthly and annual pollen counts, length of pollen season and numbers of "high" and "very high" pollen days.

Key Findings:

- Air concentrations of nitrogen dioxide, sulfur dioxide and particulate matter, have been declining over the past 20 years across NYC. The variability and trend in air pollutants are likely due to changes in precursor pollutants (pollutants that react to form ozone). Records from a database of registered non-major facilities in the five boroughs were reviewed with respect to business type and emissions, and in general, the UHF areas with the highest density of registered facilities (whether including or excluding dry cleaners) do not tend to be the same areas where asthma rates are highest. Traffic-related air pollution (TRAP) is a complex mixture of pollutants that are difficult to measure separately. Because of these challenges in assessing exposure, it can be difficult to study health effects associated with TRAP.
- Over the past 150 years, the annual average temperature and annual precipitation in Central Park show increasing trends from 1869 to 2018.

- Pollen counts at Lincoln Center, NYC, from 2010-2018 showed variations in pollen season duration across years and by pollen type. The daily average tree pollen concentration during the monitoring period was above the value considered to be high using the NAB classification, while the daily average concentrations of grass and weed pollen concentrations was below the value that the NAB classifies as high for grass or weed.

Part II: Addressing the Burden of Asthma in NY

A summary of national frameworks, guidelines, and evidence-based and best-practice strategies recommended for reducing the burden of asthma are described. Funded by the Centers for Disease Control and Prevention's (CDC) National Asthma Control Program and through an appropriation in the State budget, the Department's NYS Asthma Control Program (NYSACP) works to coordinate asthma-related agency efforts and convene key partners and stakeholders working to expand comprehensive asthma control services aimed at improving the quality of life for individuals with asthma and their families. CDC's Controlling Childhood Asthma Reducing Emergencies (CCARE) initiative aims to prevent half a million hospitalizations and ED visits among children with asthma by 2024 and achieve a reduction in avoidable health care costs. CCARE focuses on key levers to improve childhood asthma outcomes through six EXHALE strategies which use the highest level of evidence available to drive the improvement of asthma control:

E Education on asthma self-management
X Extinguishing smoking and second-hand smoke
H Home visits for trigger reduction and asthma self-management education
A Achievement of guidelines-based medical management
L Linkages and coordination of care across settings
E Environmental policies or best practices to reduce asthma triggers from indoor, outdoor, and occupational sources

Multi-sector collaboration and engagement across government, health care providers and payers, statewide associations, community-based organizations, individuals, families, and communities are vital to NY's alignment with and integration of these approaches. Policies supportive of asthma control can help to reduce asthma triggers and improve conditions where people with asthma live, learn, work, and play. The report highlights indoor air quality policies such as smoke-free housing, integrated pest management, and housing repairs, school-based policies to support effective asthma management in schools, and policies to support outdoor air quality monitoring and health advisories to notify New Yorkers when it is recommended to modify outside activities to reduce exposures to ozone and particulate matter to protect lung function and prevent worsening of asthma symptoms. The Department and NYC DOHMH have demonstrated success in serving individuals with asthma and their families across health systems, schools, and communities through the below initiatives. While not a comprehensive list, with resources and multi-sector collaboration, NY can build on these successes to reduce

the burden of asthma, particularly among populations and communities disproportionately impacted by asthma.

NYS Initiatives	NYC Initiatives
Project BREATHE NY	Asthma Medication Administration in NYC Public Schools
Healthy Neighborhoods Program	Asthma Case Management Program in NYC Community Schools
Healthy Homes Value-Based Payment Pilot	Harlem Health Advocacy Partners
DSRIP Asthma Projects	East Harlem Asthma Center of Excellence
Children's Environmental Health Centers	NYC Healthy Homes Program
Cooling Centers	
Asthma Management in Schools Initiative	
School Environmental Health Program	

Recommendations

Recommendations outlined integrate multiple strategies with strong evidence and demonstrated return on investment (ROI) shown to successfully improve asthma-related health outcomes, reduce avoidable health care costs, improve quality of life, and reduce morbidity and mortality caused by asthma. Recommendations are categorized by community, environmental, and health systems focused approaches and seek to further coordinate efforts across schools, health systems, and community-based partners to expand the delivery of quality asthma care to NY's highest risk populations. NY's success in advancing the below recommendations requires multi-sector collaboration with engagement from government, health care providers and payers, statewide associations, CBOs, and individuals, families, and communities.

Community Focused Approaches

- Continue efforts to integrate and sustainably fund Community Health Workers (CHWs), school nurses, home visiting nurses, and certified asthma educators (AE-Cs) to deliver individually tailored, culturally responsive asthma self-management education (ASME) across home-, school- and community-based settings.
- Actively promote the adoption and use of evidence-based policies supportive of asthma control across sectors, particularly in communities of color.
- Provide sufficient support of the NYS Asthma Management in Schools Initiative to ensure statewide school adoption of comprehensive asthma management programs for students with asthma which support medication adherence and include ASME and reduction of environmental asthma triggers.
- Engage local health departments and communities to achieve asthma-related objectives outlined in NY's Prevention Agenda.
- Expand awareness about the risks of SHS exposure to individuals with asthma and encourage partnering organizations to refer people who smoke to appropriate cessation interventions and to their primary care provider for counseling and cessation medications.

- Strengthen linkages between community-based partners (including schools) and health care to ensure coordination of and access to guidelines-based asthma care among communities facing health disparities.
- Maintain and expand asthma-related communication efforts and health education for health care providers and individuals with asthma and their families. Engage communities to identify related needs and preferred approaches for receiving information.
- Strengthen statewide and local anti-smoking, vaping, and e-cigarette restrictions.
- Improve community access to heating and cooling assistance among NYS residents.
- Expand availability and accessibility of cooling centers in high-risk communities.
- Work with local National Weather Service Offices to ensure vulnerable populations receive heat alerts and cooling center information.

Environmental Focused Approaches

- Improve housing quality and reduce asthma triggers by expanding adoption, implementation, and enforcement support for State and local policies such as NYC Local Law 55 which requires maintenance deficiencies to be addressed in a timely manner for individuals suffering from a respiratory condition such as asthma.
- Ensure sustainable funding for comprehensive healthy homes services which integrate asthma home-based services with energy efficiency, weatherization, and home safety services to maximize cross-sector collaboration and efficiencies.
- Expand the NYS Healthy Neighborhoods Program (HNP) to operate in every high asthma burden county statewide.
- Strengthen local building codes to require balanced ventilation and compartmentalization within multi-family housing units to prevent SHS infiltration from neighboring units.
- Increase efforts to support and enforce NYCHA's smoke-free housing policy and improve access to smoking cessation services among public housing residents.
- Expand access to and promote the use of integrated pest management (IPM) to address pest problems while minimizing impacts on health of residents and the environment.
- Avoid planting tree and shrub types that have greater allergenic pollen potential near playgrounds and senior community centers.
- Expand the public's awareness of Air Quality Health Alerts, and what they should do when one is issued to avoid a well-known asthma trigger.

Health Systems Focused Approaches

- Build NYS asthma contractor capacity to implement *Project BREATHE NY* in every high asthma burden community statewide. This would enable strategic partners to:
  - Harness NY's ongoing health care reform initiatives under the Medicaid Redesign Team (MRT) Waiver, the *NYS Roadmap for Medicaid Payment Reform*, and the NYS Health Equity Reform 1115 Waiver Amendment application to drive statewide dissemination and adoption of *Project BREATHE NY.*
  - Encourage health systems, health plan, and CBO investment in CDC's evidence-based EXHALE strategies shown to reduce avoidable asthma-related health care utilization.

- Promote uptake of a standard set of asthma measures across health systems statewide to monitor improved patient outcomes and facilitate asthma quality improvement.
- Expand patient care coordination across clinical, school, home, and community-based settings.
- Strengthen health care provider capacity to collaborate with cross-sector partners that address social determinants of health (SDH) needs including services which improve home energy efficiency such as home weatherization assistance programs for low-income families.
- Promote shared decision making which prioritizes patient and family input and engagement, recognizes family needs related to SDH, and acknowledges cultural diversity and the sustaining impacts of structural racism.

- Employ systems-level strategies and policies to support integration of comprehensive, guidelines-based asthma care services across NY's health care delivery system to:
  - Promote delivery of asthma self-management training (ASMT) and expand coverage to include services delivered in any setting by certified asthma educators (AE-C).
  - Expand use of home skilled nursing visits to deliver comprehensive home-based asthma services (including ASME and trigger reduction) for pediatric patients whose asthma is not well controlled. Ensure availability of and patient access to these services by allowing standing orders for home-based asthma visits at discharge from asthma-related ED visits/hospitalizations.
  - Provide coverage for CHWs formally trained in conducting evidence-based home asthma visits to build on promising practices identified through Delivery System Reform Incentive Payment's (DSRIP's) Asthma Projects.
  - Eliminate barriers to obtaining asthma medications and devices (e.g., co-payments, prior authorization, or refill limits) and align formularies in the NYS Medicaid pharmacy carveout to support guidelines-based prescribing recommendations.
  - Ensure every patient has a written asthma action plan and for NYC students, a Medication Administration Form (MAF), to provide necessary permissions/approvals for asthma medication management at school.
  - Develop and strengthen bidirectional data sharing and referral systems for linking patients and families to clinical, school-, home-, and community-based asthma providers and organizations addressing SDH (e.g., transportation to medical appointments, IPM, home weatherization assistance programs, tenant advocacy, etc.).
- Continue to invest in the NYS Children's Environmental Health Centers to expand existing initiatives and leverage new opportunities that support patient and provider education, policies supportive of asthma control, and partnerships dedicated to reducing the burden of asthma.

Next Steps

NYS and NYC must continue and enhance efforts to improve the lives of individuals with asthma and their families and address the unequal burden of this disease. Tackling the burden of asthma requires continued advancements in public policy, health care, research, and focused, community-based efforts to directly address the disproportionate impact of asthma on communities of color. The report reviews the current state of asthma disparities in NYS and serves as a statewide call to action to address the social and health inequities caused by structural racism and poverty that continue to plague vulnerable, at-risk children and families living with asthma. In addition, outlined evidence-based and promising best practice recommendations centering on community, schools, the environment, health systems, housing, and energy, warrant careful review and prioritization by State and local level public and private sector leaders.

Successful, coordinated implementation of recommendations requires prioritizing sustainable resources dedicated to reducing asthma burden in NY by:

1) Ensuring adequate Federal and State resources and infrastructure support for the NYSACP to lead Department and cross-agency efforts to coordinate statewide expansion of CDC's EXHALE strategies and to conduct asthma surveillance and evaluation
2) Building NYS asthma contractor capacity to serve all of NY's high asthma burden counties and securing additional resources to effectively reach target populations disproportionately burdened by asthma, including Black and Hispanic children and children living in poverty
3) Driving innovative solutions through multi-sector collaboration and investment across health, housing, energy, and education

Together, NY partners can work quickly to elevate statewide solutions which are vital to ending the needless suffering caused by asthma and emerge as a national leader in fighting the harm and unequal burden of this disease shouldered by NY's most vulnerable children and families.

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Introduction

This report was developed by the New York State Department of Health (the Department) in response to Article VII, Part MM included in the SFY 2018-2019 State budget which stated:

> 18 § 9. a. Notwithstanding any contrary provision of law, the commission-
> 19 er of the New York state department of health is hereby authorized and
> 20 directed to prepare or have prepared a study of, and recommendations
> 21 for, evidence-based interventions to address the high burden of asthma
> 22 in the boroughs of Brooklyn and Manhattan in the city of New York. Such
> 23 study shall include an analysis of high-risk neighborhoods examining
> 24 disparities in: income, race and ethnicity, public and private housing,
> 25 and proximity to major sources of air pollution.
> 26 b. The study and recommendations authorized pursuant to subdivision a
> 27 of this section shall be completed within twenty-four months of the
> 28 effective date of this act.

In response to the above mandated legislation, the report was compiled by the Department's Office of Public Health with contributions from the New York City (NYC) Department of Health and Mental Hygiene (DOHMH) to provide:

- An overview of the burden of asthma statewide and in NYC neighborhoods
- A review of high-risk neighborhoods disproportionately impacted by asthma
- A review of indoor and outdoor environmental triggers and allergens and outdoor air quality
- Evidence-based and best practice recommendations for policies, strategies, and interventions supportive of asthma control

The Department created a working group to develop a project timeline and plan for completion. During the process, the working group engaged various governmental and academic professionals, community-based organizations (CBOs), and stakeholders from NYC, including NYC DOHMH, to provide technical input, review, and feedback on the proposed timeline and plan. The Department drafted this report in 2019-2020, but due to the COVID-19 pandemic and other factors, the report is being released in 2023.

Stakeholder discussions resulted in the following key decisions regarding the format and content of the final report:

1. The report considers all five boroughs of NYC to ensure responsiveness to areas facing the highest burden of asthma.
2. The report uses only existing data, including data collected by NYC agencies which are uniquely available for NYC that would not be available in other cities of New York State (NYS). Given the timeline and lack of allocated resources to this report, no new data were collected.

Asthma is a chronic disease of the lungs that causes wheezing, breathlessness, chest tightness, and coughing. Asthma continues to be a major public health problem in the United States (US), and asthma that is not well controlled can diminish quality of life. The exact cause of asthma is unknown, but it is understood to be a multifactorial disease and both genetic and environmental factors can affect asthma incidence.[1] While not curable, asthma can be controlled using current clinical guidelines set by the National Asthma Education and Prevention Program (NAEPP).[2] Asthma exacerbations can be impacted by multiple factors, including asthma severity and control status, access to care, medication adherence, and environmental triggers. NAEPP's guidelines for diagnosing and managing asthma outline evidence-based guidance for delivering appropriate medical care with assessment of asthma severity and control status, providing asthma self-management education (ASME), and identifying and managing environmental triggers.

WHAT IS ASTHMA?

The Centers for Disease Control and Prevention (CDC) defines asthma as a disease that affects your lungs. It causes repeated episodes of wheezing, breathlessness, chest tightness, and nighttime or early morning coughing.

Asthma can be controlled by taking medicine and avoiding the triggers that can cause an attack. Asthma triggers must also be removed from one's environment as triggers can make asthma worse.

Both indoor and outdoor environmental sources contribute to the development and exacerbation of asthma.[3, 4] Indoor sources that have been associated with the development or exacerbation of asthma include nitrogen dioxide emissions from unvented natural-gas appliances; environmental tobacco smoke; allergens (including those produced by pets, dust mites, rodents and cockroaches); irritant chemicals; pollen and mold allergens; dampness and smoke.[5, 6] Outdoor air pollutants that can exacerbate symptoms in those with asthma include ozone, sulfur dioxide, and fine particles.[3] Weather can also impact patterns of asthma and allergic disorders by influencing the presence, onset, duration, and production of seasonal triggers, such as pollen. Due to comorbidities, seasonal impacts, and the influences of indoor and outdoor air quality, asthma-

[1] Forno, E. Health disparities in asthma. AJRCCM. 2012; 185(10):1033-1043. doi/full/10.1164/rccm.201202-0350ED
[2] National Asthma Education and Prevention Program. Expert Panel Report 3: Guidelines for the diagnosis and management of asthma. NIH pub. no. 07-4051.Bethesda, MD: National Heart, Lung, and Blood Institutes of Health. 2007. https://www.nhlbi.nih.gov/health-topics/guidelines-for-diagnosis-management-of-asthma. Last accessed January 3, 2018.
[3] Guarnieri, M. B., J.R. Outdoor air pollution and asthma. Lancet. 2014; 383: 1581-1592 4 Kanchongkittiphon, W., Mendell, M.J., Gaffin, J.M., Wang, G. & Phipatanakul, W.
[4] Indoor environmental exposures and exacerbation of asthma: an update to the 2000 review by the Institute of Medicine. Environmental health perspectives. 2015; 123: 6-20 5
[5] U.S. Department of Housing and Urban Development. *About Asthma.* https://www.hud.gov/program_offices/healthy_homes/healthyhomes/asthma
[6] Institute of Medicine. Clearingthe Air: Asthmaand Indoor Air. 2000 https://www.nap.edu/read/9610/chapter/1#viii. Last accessed January 3, 2018.

related emergency department (ED) and hospitalization rates fluctuate throughout the year and vary by geographical region.

Asthma also affects certain groups disproportionately, rendering significant disparities including higher rates of ED visits, hospitalizations, and deaths. The reasons for these disparities are multifactorial and include economic, social, and cultural factors. Individuals may also face housing and/or work-related conditions that place them at greater risk for exposure to environmental allergens and irritants that can worsen asthma. Current asthma prevalence is higher among Black, American Indian, and multiracial New York adults.[7] Morbidity and mortality rates for asthma are higher for racial minorities, younger age groups, and those of lower socio-economic status (SES). Higher poverty rates among Black and/or Hispanic residents may contribute to these disparities. In general, low-income minority populations have poorer asthma control, in part because populations with lower SES are more likely to live in neighborhoods with sub-standard housing conditions. This results in increased exposure to common asthma triggers such as cockroaches, mice, and other pests, and poor building conditions, including leaks and mold. [8] In addition to exposure to environmental triggers, asthma morbidity and mortality rates are correlated with income and insurance coverage, which may impact healthcare quality and access.[9]

Part I: Asthma Burden, Data Review, and Trends

Asthma in the United States is both common and costly. While both adults and children can suffer from asthma, it is one of the most common chronic diseases among children. The burden of childhood asthma not only affects the child, but also their caregivers and families in terms of missed school and workdays due to asthma and other impacts on quality of life. According to recent publications, it is estimated that asthma was responsible for $3 billion in losses due to missed work and school days and $50.3 billion in medical costs.[10] In addition, asthma accounts for 1.8 million emergency department visits, more than 14 million physician office visits and over 439,000 hospitalizations in the US.[11] A large portion of these visits are potentially avoidable with better asthma control. Asthma burden is measured and described by aspects such as those who have received a diagnosis of asthma, the prevalence of asthma episodes or attacks, asthma-related ED visits and hospitalizations, missed school/workdays due to asthma, and deaths due to asthma. In general, poorer asthma control results in more frequent and intense exacerbations which may require urgent, unscheduled care, hospitalizations, and/or intensive care unit admissions. Application of guidelines-based care leads to better asthma control and disease management.

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[7] New York State Asthma Dashboard. https://www.health.ny.gov/asthmadashboard

[8] Forno, E. & Celedón, J.C. Asthma and ethnic minorities: socioeconomic status and beyond. Curr Opin Allergy Clin Immunol. 2009;9(2):154-160.

[9] Holsey, C.N., Collins, P., & Zahran, H. Disparities in asthma care, management, and education among children with asthma. Clin Pulm Med. 2013; 20(4):172-177.10.1097/CPM.0b013e3182991146

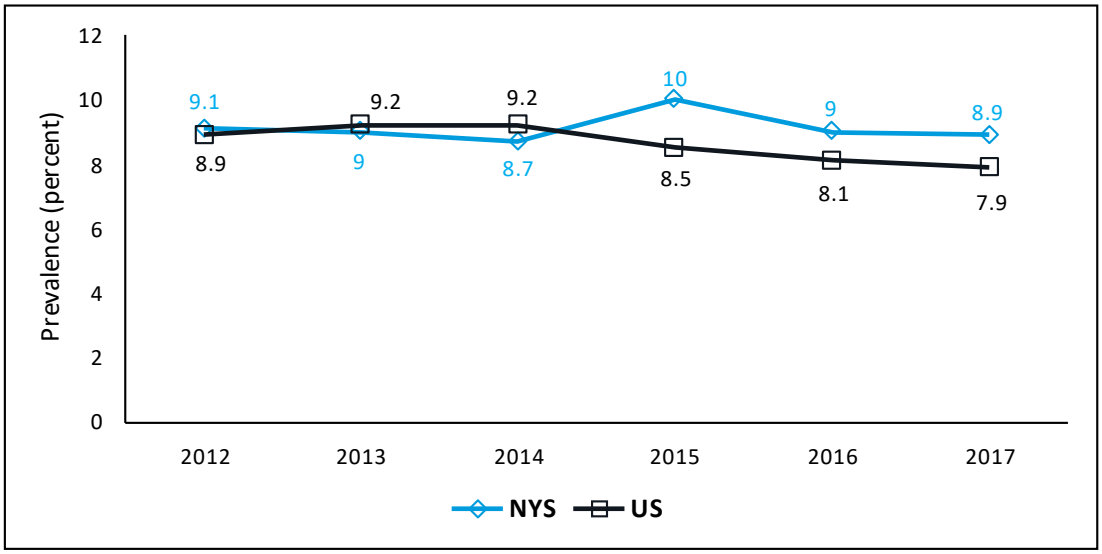
[10] Nurmagambetov, T., Kuwahara, R. and Garbe, P., 2018. The Economic Burden of Asthma in the United States, 2008–2013. Annals of the American Thoracic Society, 15(3), pp.348-356.

[11] Centers for Disease Control and Prevention. 2013. ASTHMA FACTS. Available at <https://www.cdc.gov/asthma/pdfs/asthma_facts_program_grantees.pdf> [Accessed 8 April 2021].

US and NYS

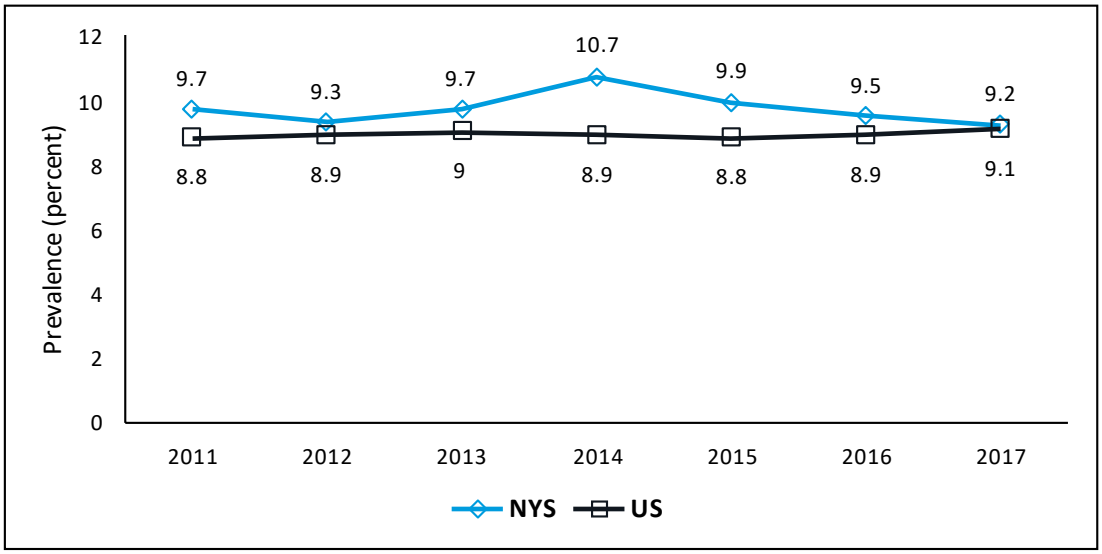
Asthma prevalence is measured via the Behavioral Risk Factor Surveillance System by assessing the number of people who have ever been told by a healthcare provider that they have asthma. In the US in 2017, 7.9 percent of children ages 0-17 (3.5 million) and 9.1 percent of adults (22.7 million) indicated they currently had asthma. In NYS (including NYC) in 2017, 8.9 percent of children (~355,000) and 9.2 percent of adults indicated they currently had asthma. These prevalence estimates have remained fairly consistent over the last several years (Figures 1, 2).

Figure 1. Current asthma prevalence (percent) among children (0-17 years) for NYS and US, 2011-2017



Data source: Behavioral Risk Factor Surveillance System (BRFSS) Asthma Prevalence Data

Figure 2. Current asthma prevalence (percent) among adults (≥18 years) for NYS and US, 2011-2017

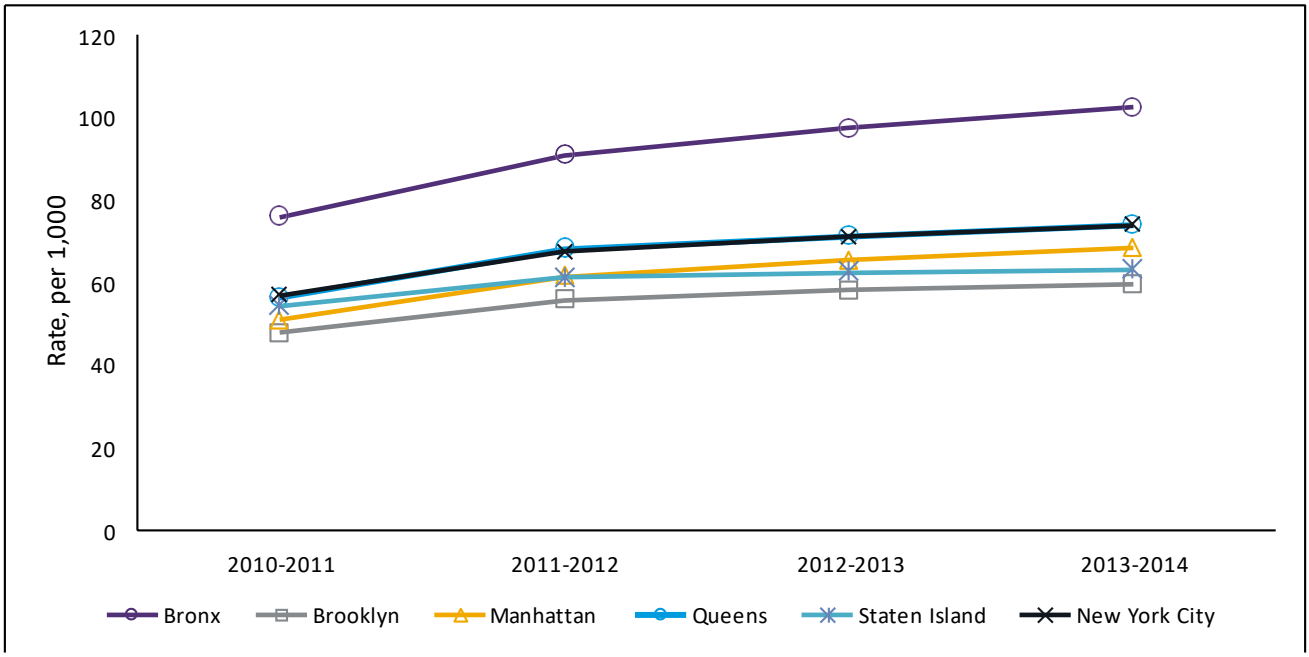


Data source: Behavioral Risk Factor Surveillance System (BRFSS) Asthma Prevalence Data

NYC

Asthma prevalence rates for NYC among children enrolled in public school can be measured by the number of those children with a diagnosis of asthma. As seen in Figure 3, the rate of asthma diagnoses among school children increased by almost 30 percent from 56.8 per 1,000 in the 2010-2011 time period to 73.8 per 1,000 in the 2013-2014 time period. Children in the Bronx had a rate of 102.5 per 1,000 in 2013-2014, and consistently had the highest rate of all five NYC boroughs.

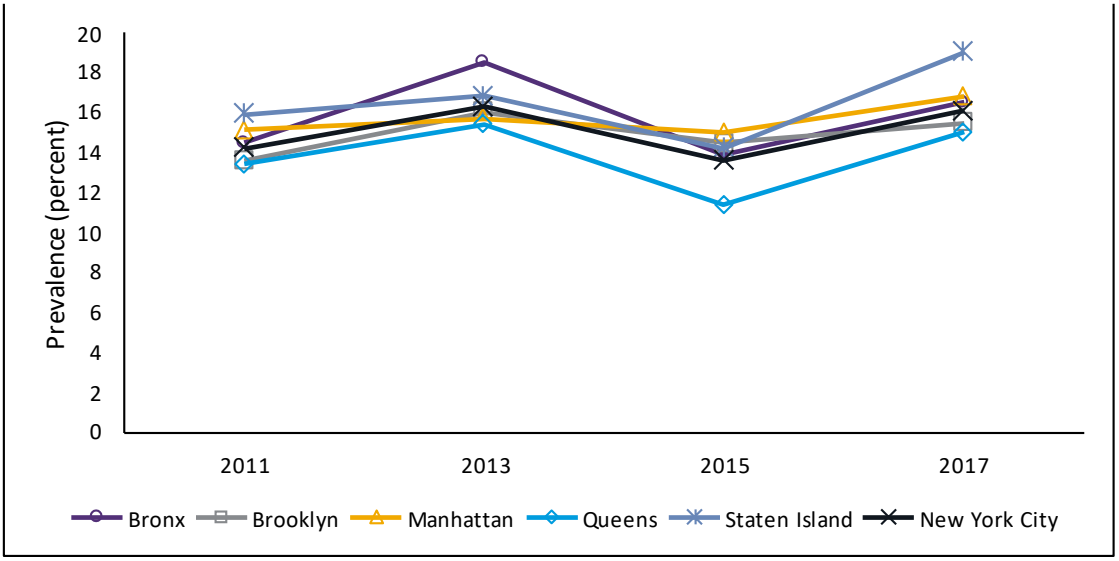
Figure 3. Rate* of children (5-14 years) enrolled in NYC public schools with a diagnosis of asthma during the current or previous school year, 2010-2011 to 2013-2014



Data source: NYC Automated School Health Records, data from NYC DOHMH Environment and Health Data Portal
*Rates are calculated by residence of the child

The NYC Youth Risk Behavioral Survey asks about chronic conditions including recent asthma exacerbations. The percentage of high school students in NYC who reported having had an asthma attack in the past year was 16.1 percent in 2017 and has fluctuated since 2011. High school students in Staten Island were most likely to report that they had an asthma attack in the past year (19 percent), followed by Manhattan (16.8 percent) and the Bronx (16.5 percent). Brooklyn (15.5 percent) and Queens (15 percent) had lower percentages than NYC.

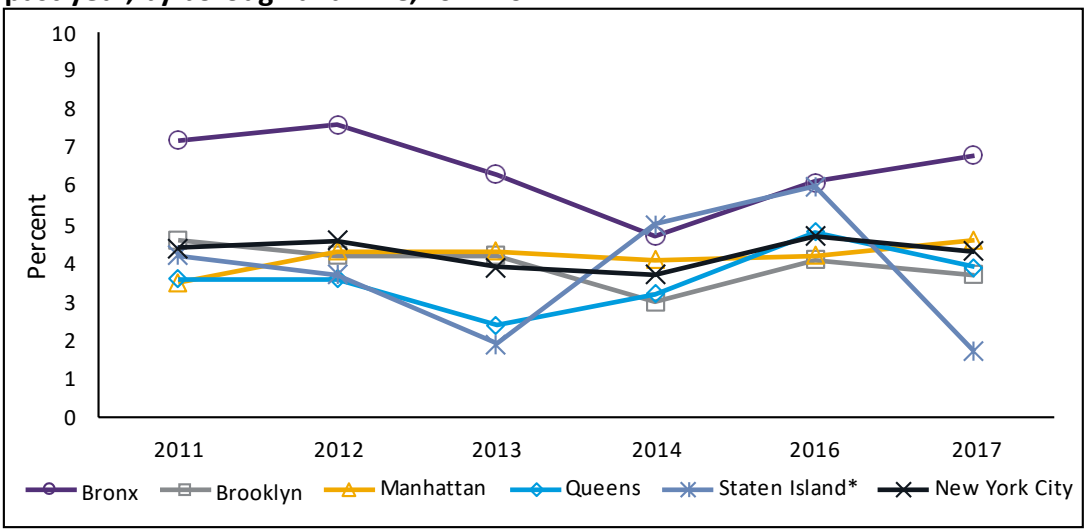
Figure 4. Percentage of NYC public high school students (9th -12th grade) schools who reported having had an asthma attack in the past year, 2011-2017



Data source: New York City Youth Risk Behavioral Survey, data from NYC DOHMH EpiQuery

There has been variation across the five boroughs in NYC in the age-adjusted rate of adults reporting an asthma attack in the past year. However, the Bronx has generally had higher rates than the other boroughs and NYC overall. In 2017, the Bronx had the highest percentage of adults who reported having an asthma attack in the past year (6.8 percent), followed by Manhattan (4.6 percent). Queens (3.9 percent) and Brooklyn (3.7 percent) had lower percentages of adults reporting having had an asthma attack than NYC overall.

Figure 5. Age-adjusted percentage of adults (≥18 years) who have had an asthma attack in the past year, by borough and NYC, 2011-2017



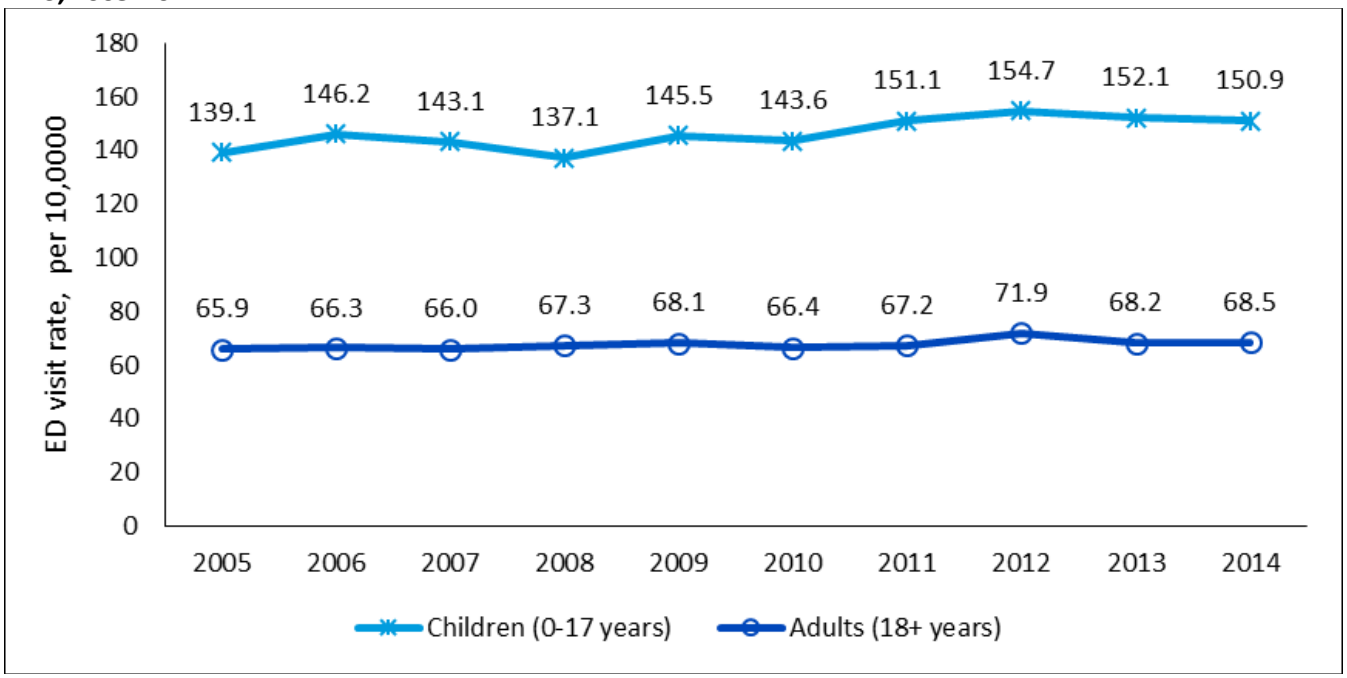
Data source: New York City Community Health Survey (CHS)
*Estimate for Staten Island for all years, except 2014, is based on small numbers and should be interpreted with caution.

Asthma ED Visits and Hospitalizations

Asthma-related ED visits and hospitalizations are key indicators for measuring the burden of asthma and assessing progress towards using a comprehensive approach to control asthma. Note that due to the adoption of the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10CM) by the Centers for Medicare & Medicaid Services starting October 2015, the ICD-10CM codes are not comparable to the ICD-9CM codes. Therefore, asthma ED and hospitalization data for 2014 and prior years (using the ICD-9CM codes) are used to ensure trend data are comparable during the time period being displayed. In NYS, asthma ED visit rates for both children and adults rose from 2005 until 2012. Among children, the ED visit rate increased by 11.2 percent from 139.1 per 10,000 in 2005 to 154.7 per 10,000 in 2012. Among adults the rate increased by 10.5 percent from 85.4 per 10,000 in 2005 to 94.4 per 10,000 in 2012. ED visit rates for both children and adults then declined from 2012 to 2014.

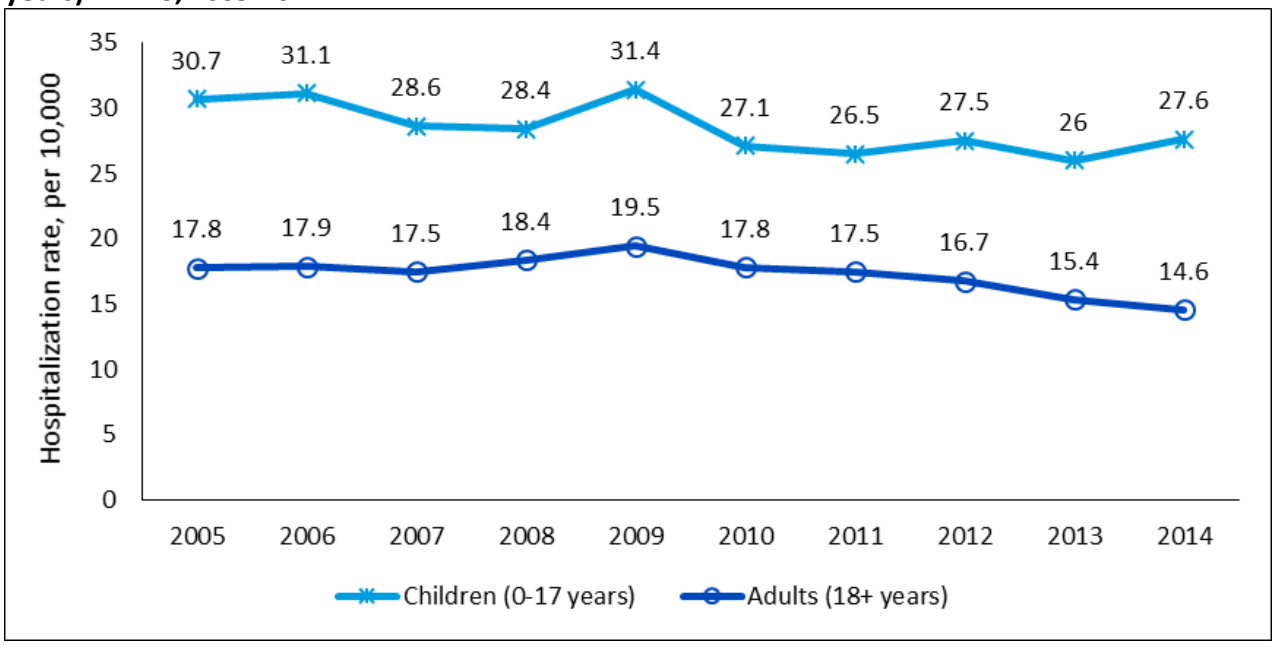
Hospitalizations due to asthma have decreased for both children and adults. Among children, the statewide rate decreased by 10.1 percent from 30.7 per 10,000 in 2005 to 27.6 per 10,000 in 2014. Among adults, the rate decreased by 16.3 percent from 20.8 per 10,000 in 2005 to 17.4 per 10,000 in 2014. Similar to the trend in ED visits, hospitalization rates for children are higher than among adults.

Figure 6. Asthma ED visits, per 10,000, among children (0-17 years) and adults (≥18 years) in NYS, 2005-2014



Data source: Statewide Planning and Research Cooperative System (SPARCS)

Figure 7. Asthma hospitalizations, per 10,000, among children (0-17 years) and adults (≥18 years) in NYS, 2005-2014

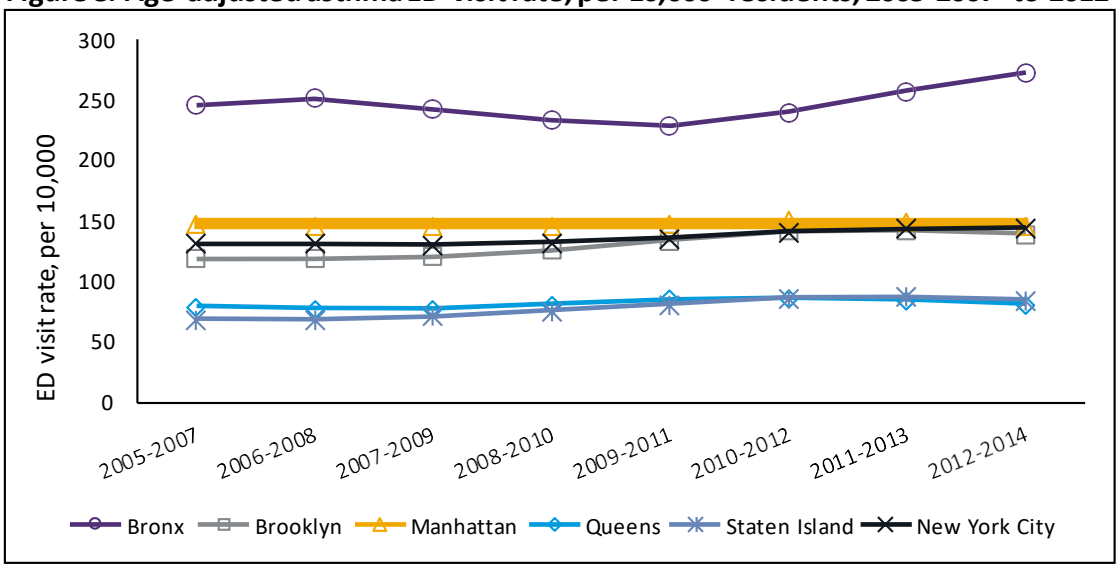


Data source: Statewide Planning and Research Cooperative System (SPARCS)

Asthma ED Visits and Hospitalizations in NYC

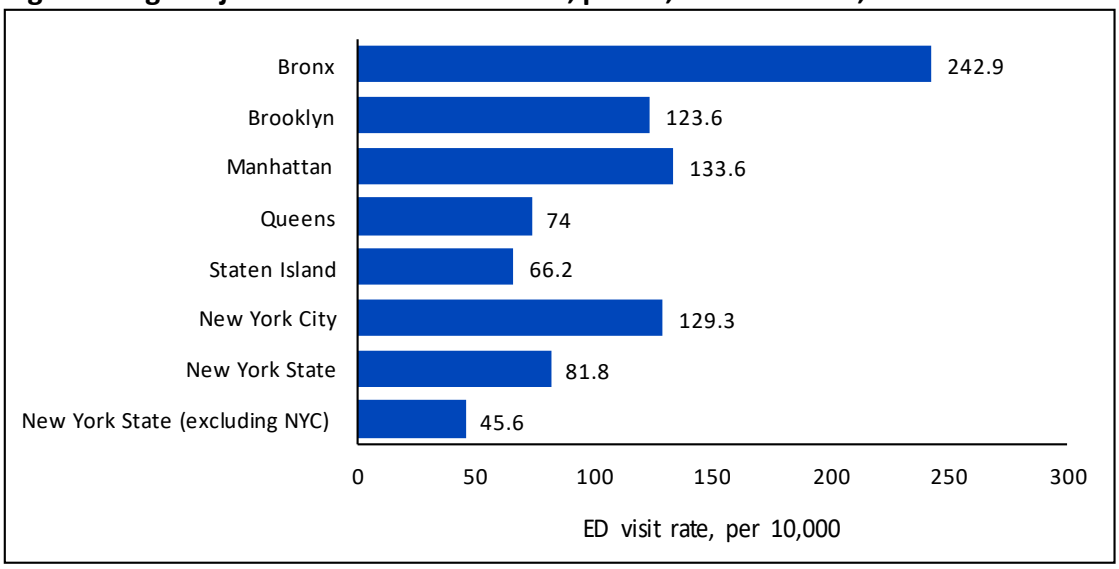
The overall spatial patterns in asthma burden by NYC borough have remained consistent over time (Figure 8). Compared to all the boroughs, the Bronx has had the highest ED visit rate since 2005-2007 and has experienced rising rates in recent years. Brooklyn and Manhattan rates have been lower than Bronx rates but higher than rates in Queens and Staten Island. These patterns have held even after changes in the surveillance definition of asthma in 2015. In 2016, the age-adjusted ED visit rate for NYC (129.3 visits per 10,000 residents) was 1.6 times higher than the age-adjusted ED visit rate for NYS (81.8 visits per 10,000 residents) and 2.8 times higher than the age-adjusted ED visit rate for NYS excluding NYC (45.6 visits per 10,000 residents) (Figure 9). Total ED visits and ED visit rates were highest in the Bronx, Manhattan, and Brooklyn. The Bronx had an ED visit rate of 242.9 visits per 10,000 residents, which was 1.9 times the rate for NYC. Manhattan (133.6 per 10,000) had a rate only slightly more than NYC. Brooklyn (123.6 per 10,000), Queens (74 per 10,000) and Staten Island (66.2 per 10,000) had rates lower than NYC but higher than NYS excluding NYC. Similar spatial patterns were observed for ED visits among children and for hospitalizations.

Figure 8. Age-adjusted asthma ED visit rate, per 10,000 residents, 2005-2007 to 2012-2014



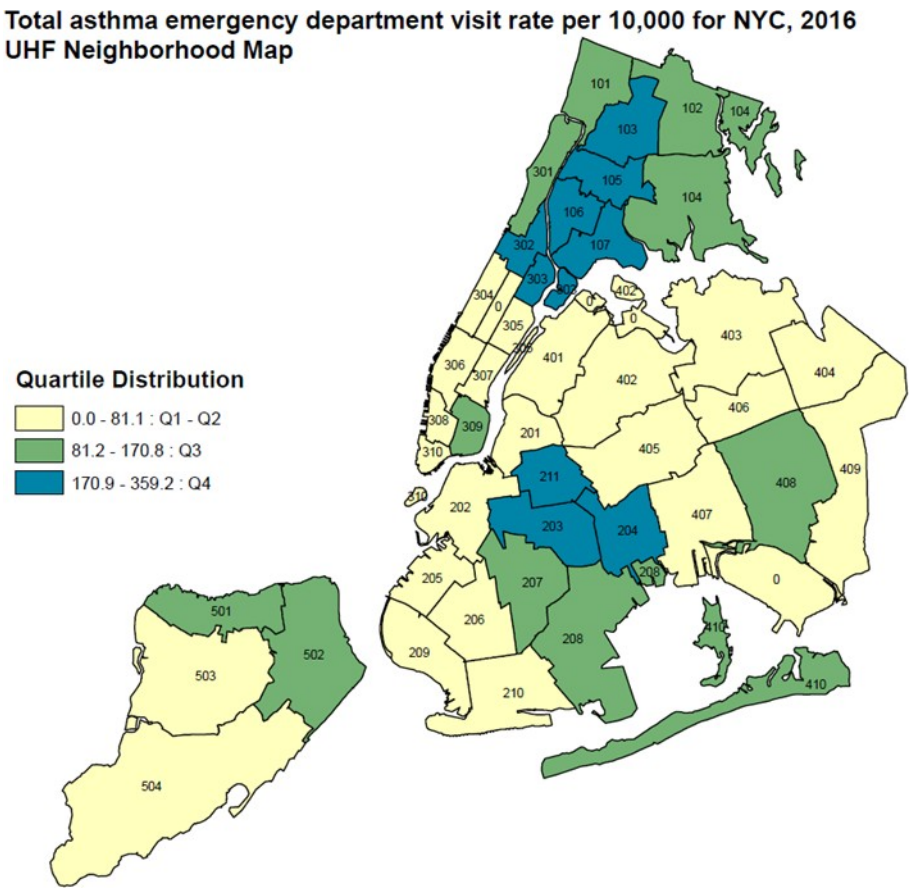
Data source: Statewide Planning and Research Cooperative System (SPARCS)

Figure 9. Age-adjusted asthma ED visit rate, per 10,000 residents, 2016



Data source: Statewide Planning and Research Cooperative System (SPARCS)

Closer observation of ED visit rates by the 42 United Hospital Fund neighborhoods (UHF-42) reveals significant variation across neighborhoods below borough level. UHF-42 neighborhoods are an existing classification based upon ZIP codes and were created by NYC agencies to approximate Community Planning Districts.[12] UHF-42 neighborhoods in the Bronx, eastern Brooklyn, and northern Manhattan, have especially high asthma ED visit rates. The following neighborhoods in the Bronx, Manhattan, and Brooklyn made up the highest ED visit rate category (170.9-359.2 ED visits per 10,000 residents):



Bronx

- UHF code 103, Fordham-Bronx Park
- UHF code 105, Crotona-Tremont
- UHF code 106, High Bridge-Morrisania
- UHF code 107, Hunts Point-Mott Haven

Manhattan

- UHF code 302, Central Harlem-Morningside Heights
- UHF code 303, East Harlem

Brooklyn

- UHF code 203, Bedford Stuyvesant-Crown Heights
- UHF code 204, East New York
- UHF code 211, Williamsburg-Bushwick

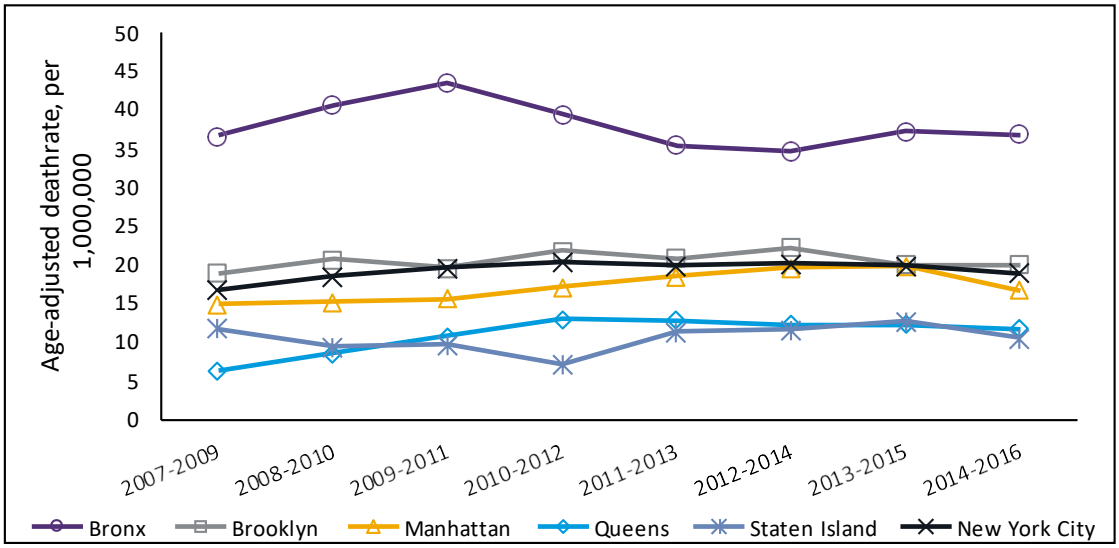
<u>Mortality</u>

The age-adjusted asthma mortality rate for NYS (data not shown) is lower than for NYC. For NYC, the age-adjusted asthma mortality rate remained relatively consistent between 2007-2009 and 2014-2016. The Bronx has had a substantially higher mortality rate than other boroughs of NYC. Although the rate for the Bronx declined by 15.4% from 43.5 per million in the 2009-2011 time period to 36.8 per million in 2014-2016, as of the 2014-2016 time period the rate remained

[12] NYC UHF-42 42 Neighborhoods. http://a816-dohbesp.nyc.gov/IndicatorPublic/EPHTPDF/uhf42.pdf.

almost twice the rate for NYC (18.9 per million). During the 2014-2016 time period, Brooklyn's rate of 20 per million was slightly higher than the rate for NYC. Manhattan (16.8 per million), Queens (11.8 per million) and Staten Island (10.6 per million) had lower asthma death rates than NYC.

Figure 10. Age-adjusted asthma death rate, per 1,000,000, in NYC, from 2007-2009 to 2014-2016



Data source: Vital Statistics as of April 2018

Review of Sociodemographic Disparities

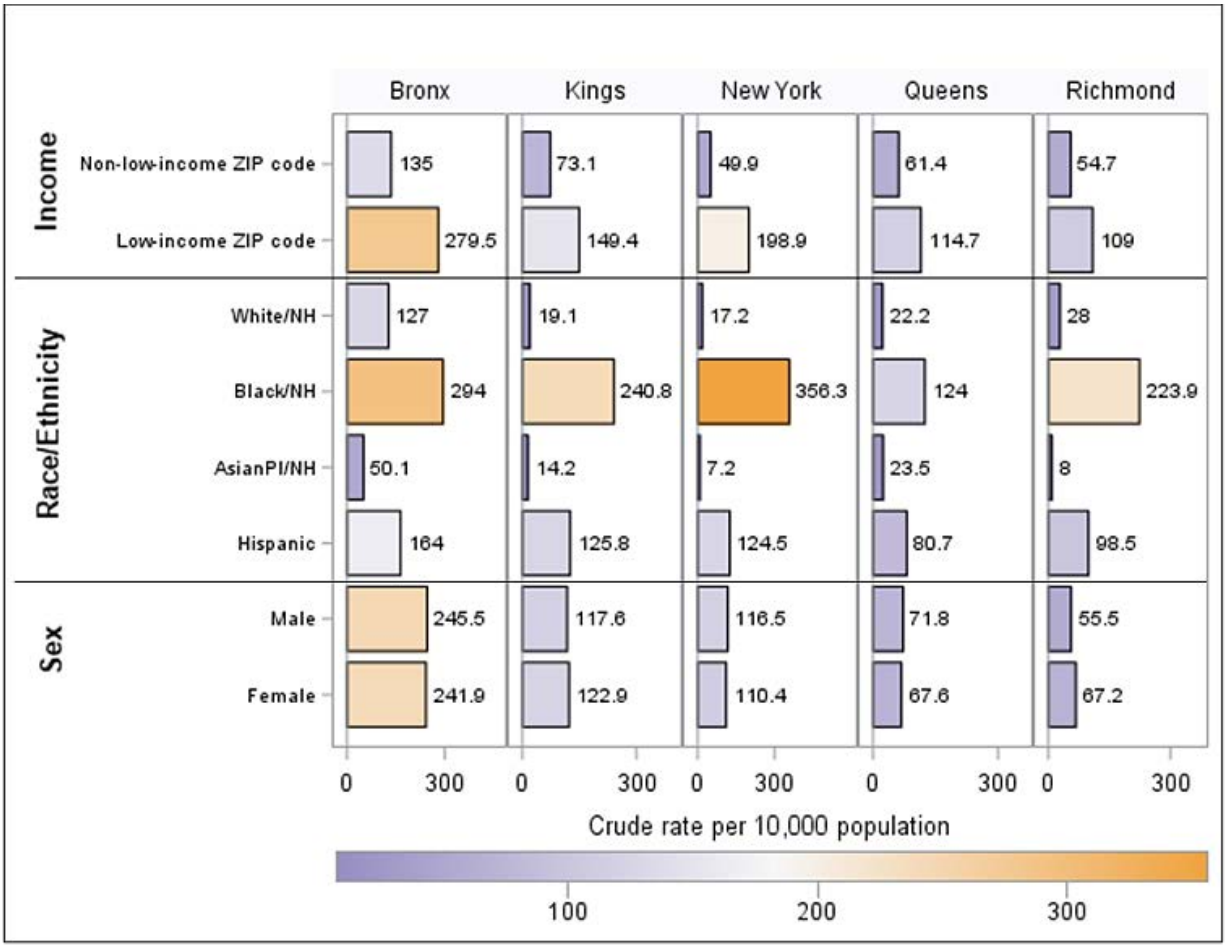
Disparities in asthma for sociodemographic factors including race and ethnicity, income, public and private housing, and proximity to major sources of air pollution were assessed. For each sociodemographic indicator, the charts and tables below highlight differences by groups.

Asthma is a multi-factorial condition and exacerbations are influenced by factors such as access to care and exposure to environmental triggers. Asthma prevalence, ED visits, hospitalizations, and mortality rates differ by age, gender, race, and geographic region. Higher poverty rates among Black and/or Hispanic residents may contribute to these disparities. In general, low-income minority populations have poorer asthma control, in part because populations with lower socio-economic status (SES) are more likely to live in neighborhoods with sub-standard housing conditions. This results in increased exposure to common asthma triggers such as cockroaches, mice, and other pests, and poor building conditions, including leaks and mold. Those of lower SES are also more likely to smoke or be exposed to second-hand smoke (SHS). In addition to exposure to environmental triggers, asthma morbidity and mortality rates are correlated with income and insurance coverage, which may impact healthcare quality and access.[13] Morbidity and mortality rates for asthma are higher for racial minorities, younger age groups, and those of lower SES.

[13] Centers for Disease Control and Prevention& U.S. Department of Housing and Urban Development. Healthy housing reference manual. (US Department of Health and Human Services, Atlanta, 2006).

Disparities in asthma exacerbations were evaluated using asthma ED visit rates to examine categories of income, race/ethnicity, and sex for each NYC county/borough (Figure 11). Asthma ED visit rates among categories in the Bronx were generally higher than the same categories in other counties. Low-income ZIP codes and Black non-Hispanics consistently had higher asthma ED visit rates than comparison categories within the same county, while differences by sex were smaller and not consistent. Asthma ED visit rates for low-income ZIP codes were highest in the Bronx (279.5 per 10,000), followed by Manhattan (198.9 per 10,000), and Brooklyn (149.4 per 10,000). Rates for Black non-Hispanic New Yorkers were highest in Manhattan (358.3 per 10,000), followed by the Bronx (294 per 10,000) and Brooklyn (240.8 per 10,000). For both men and women, rates were highest in the Bronx (245.5 per 10,000 and 241.9 per 10,000, respectively). Men had higher rates than women in the Bronx, Manhattan, and Queens, while women had higher rates in Brooklyn and Staten Island. Patterns in sociodemographic disparities were similar among children for income and race/ethnicity (not shown).

Figure 11. Asthma ED visit rate, per 10,000 residents, 2016



Data sources: Statewide Planning and Research Cooperative System (SPARCS), American Community Survey (ACS)

Review of Indoor Environmental Triggers and Allergens

Asthma triggers are numerous and vary by individual, geographic location, season, and other factors. Both indoor and outdoor environmental factors can contribute to the onset and exacerbation of asthma. Learning more about exposure to asthma triggers and related environmental factors can help individuals with asthma and their families/caregivers prevent or reduce asthma symptoms and help health practitioners better support patients in managing their asthma. The following sections of this report will describe both indoor and outdoor environmental factors that impact asthma development and exacerbation.

The assessment of indoor and outdoor environmental triggers and allergens (i.e., environmental indicators) was informed by a review of existing literature and includes joint input from the Department and external partners. This work was facilitated by the large number of datasets NYC agencies make available, many of which are summarized at the UHF-42 level. Details on the data sources used in this report can be found in Appendix A.

Charts and maps summarize indicators and, where appropriate, better understand patterns across NYC. For some indicators, scatterplots of UHF-42 neighborhood asthma ED visit rates and indoor indicators are presented to better understand community-level correlations. **It is important to note that these scatterplots summarize correlations at the UHF-42 level and do not establish a causal link between the environmental indicator and asthma. Because this report has not collected individual level data, it cannot confirm that people who have asthma are being exposed to the indoor or outdoor environmental triggers that have been reviewed.**

Dampness, Leaks and Mold

Previous studies have associated indoor dampness with asthma and other respiratory illness.[14, 15, 16, 17] The presence of excess moisture, humidity, noticeable musty odors, or water leaks signal dampness, which can lead to mold, fungal, and bacterial growth, and their production and release of spores or metabolites. Mold spores are potential triggers for asthma according to the Institute of Medicine (IOM).[16] Mold spores are found everywhere and will grow almost anywhere that has sufficient moisture and organic matrices. [17, 18]

When inhaled, mold spores or mold fragments can act as allergens and irritants that cause inflammation of the lung and airways and exacerbate asthma.[19] Presence of indoor mold or exposure to damp indoor environments can trigger asthma symptoms in sensitized asthmatic

[14] Heseltine, E. & Rosen, J. WHO guidelines for indoor air quality: dampness and mold. (WHO Regional Office Europe, 2009).

[15] Centers for Disease Control and Prevention. Mold, https://www.cdc.gov/mold/dampness_facts.htm (2017).

[16] Kanchongkittiphon, W., Mendell, M. J., Gaffin, J. M., Wang, G. & Phipatanakul, W. Indoor environmental exposures and exacerbation of asthma: an update to the 2000 review by the Institute of Medicine. Environmental health perspectives 123, 6-20 (2014).

[17] Centers for Disease Control and Prevention& U.S. Department of Housing and Urban Development. Healthy housing reference manual. (US Department of Health and Human Services, Atlanta, 2006).

[18] Institute of Medicine (IOM). Damp Indoor Spaces and Health. (The National Academies Press, 2004)

[19] New York State Department of Health. *Mold and Your Home: What You Need to Know*, https://www.health.ny.gov/publications/7287.pdf

persons, as well as cause coughing, wheezing, and other respiratory symptoms in otherwise healthy individuals.[15,18] Occupants of damp or moldy buildings are at an elevated risk of respiratory symptoms, infections, asthma development and exacerbations.[14] A study conducted in NYC found that children residing in homes with reported leaks were about 1.5 times likely to have asthma than children living in homes with no leaks.[20] Another study observed that dampness in the home increased the risk of persistent wheezing and the severity and frequency of wheezing in children.[21]

Overall, nearly 17% of households reported leaks on the 2014 NYC Housing and Vacancy Survey (HVS), ranging from 8.5% households in Staten Island to 23% of households in the Bronx.[22] Among the UHF-42 neighborhoods, the High Bridge-Morrisania neighborhood in the Bronx reported the highest percentage (32%) of homes with leaks, followed by the Washington Heights-Inwood neighborhood (29.8%) in Upper Manhattan, and the Crotona-Tremont neighborhood in the Bronx (28.5%) (Figure 12). Survey respondents from several neighborhoods in Brooklyn, including Bedford Stuyvesant-Crown Heights (26.5%), East Flatbush-Flatbush (25.6%) and Downtown-Heights-Slope (23.6%), and one neighborhood in the Bronx, Hunts Point-Mott Haven (25.5%), also reported leaks more than 25% of the time.

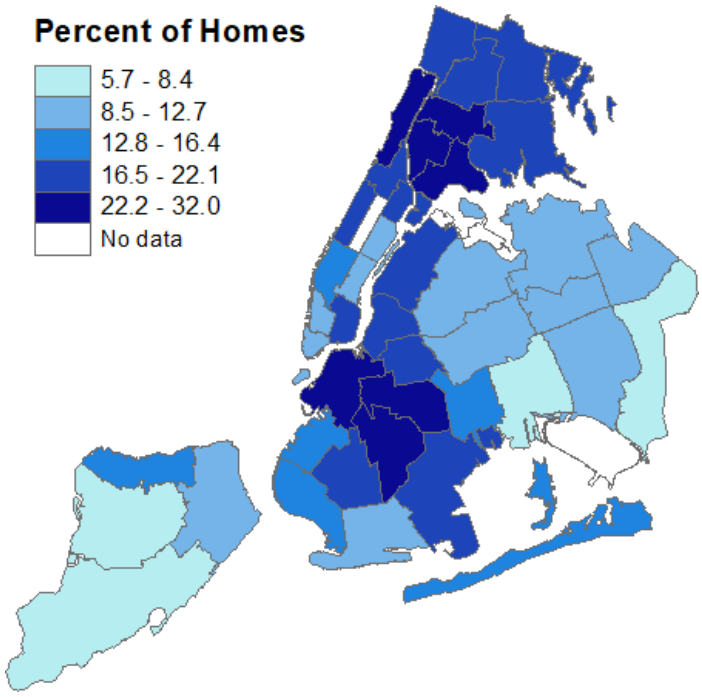


Figure 12. Percent of homes with leaks in 2014, by UHF-42 Neighborhoods in NYC

Data Source: 2014 New York City Housing and Vacancy Survey

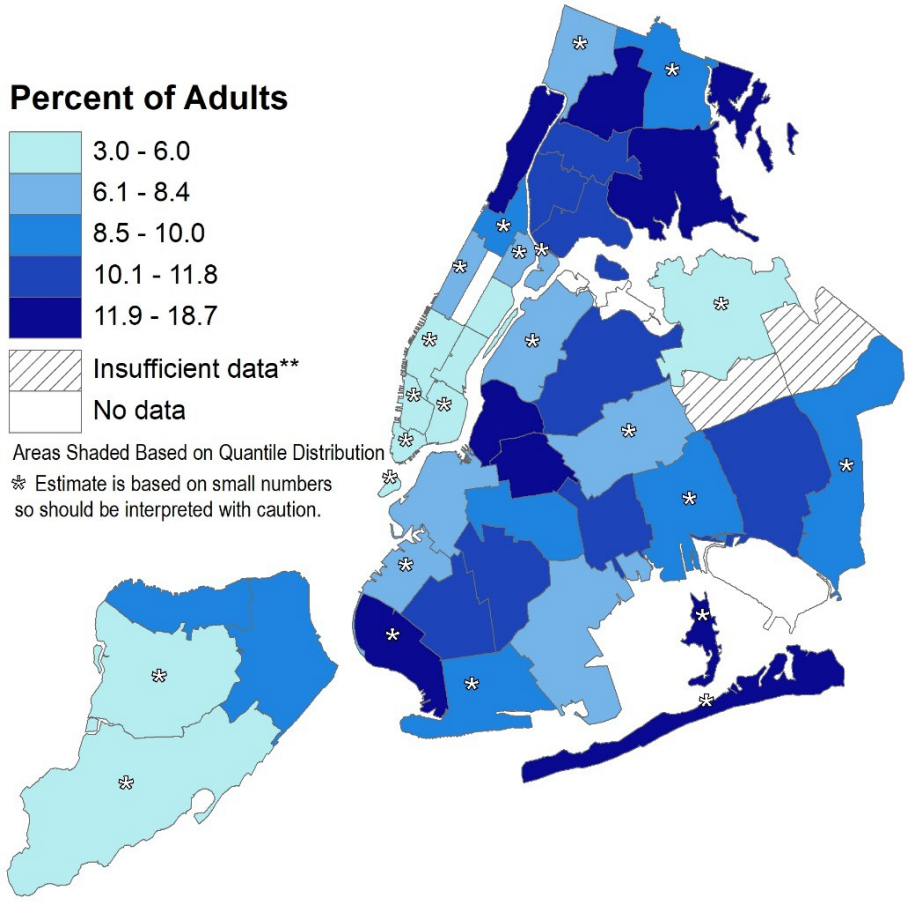
[20] Northridge, J., Ramirez, O. F., Stingone, J. A. & Claudio, L. The role of housing type and housing quality in urban children with asthma. *Journal of Urban Health* **87**, 211-224 (2010).

[21] Venn, A. et al. Effects of volatile organic compounds, damp, and other environmental exposures in the home on wheezing illness in children. Thorax 58, 955-960 (2003).

[22] New York City Department of Health and Mental Hygiene. *Homes with Leaks*, http://a816-dohbesp.nyc.gov/IndicatorPublic/VisualizationData.aspx?id=42,719b87,36,Summarize

Based on the 2012 NYC Community Health Survey (CHS), which collected self-reported data on mold, 9.5% of respondents reported mold in the home, with the highest percentage reported among adults in the Bronx (12.9%).[23] The Fordham-Bronx Park neighborhood in the Bronx had the highest percentage of adults (18.7%) reporting mold in at least one room in their buildings (excluding the bathroom) in the past 30 days (Figure 13). Approximately 17% of adults in the Washington Heights neighborhood in Upper Manhattan reported mold, followed by Greenport (16%) in Brooklyn and Pelham-Throgs Neck (14.4%) neighborhood in the Bronx.

Figure 13. Percent of Adults Reporting Mold in the home in 2012, by UHF-42 Neighborhoods in NYC



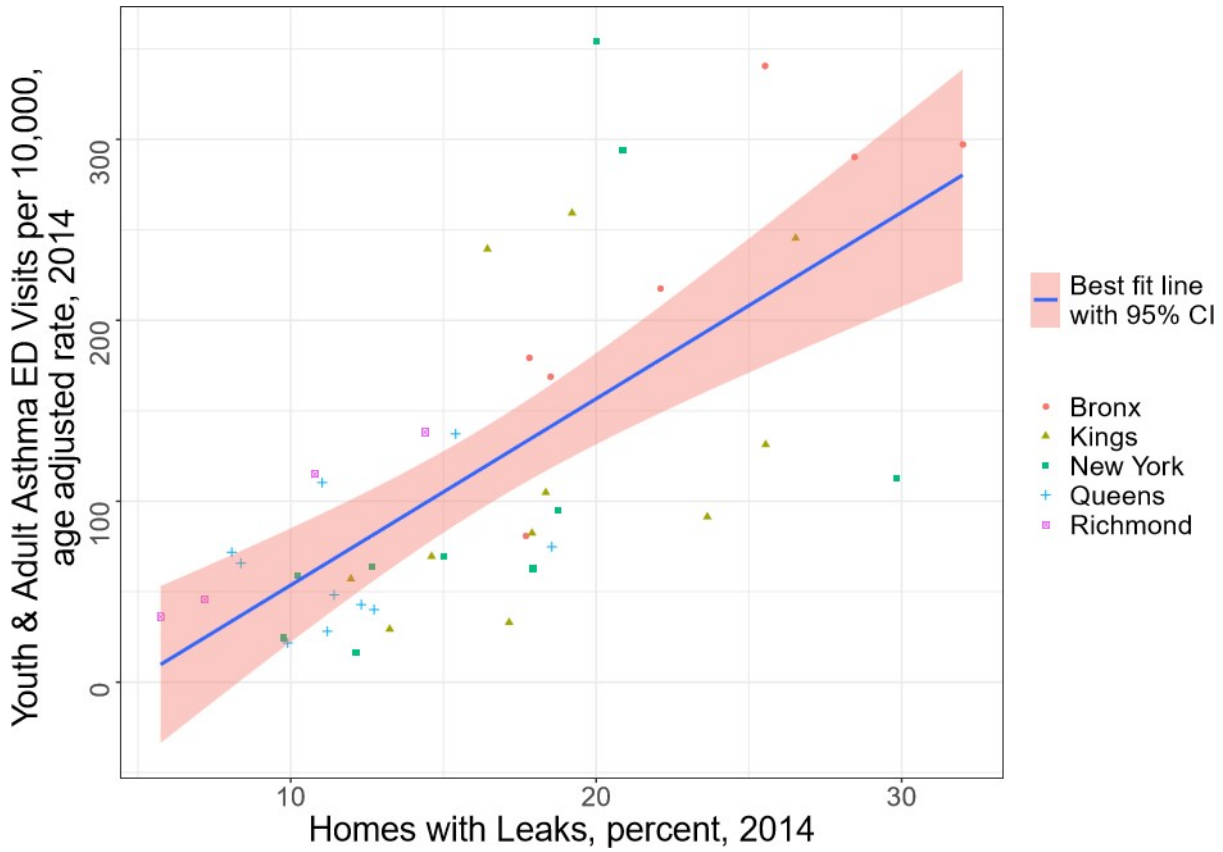
Source: New York City Community Health Survey
** Estimate is supressed due to insufficient data.

Data Source: 2012 New York City Community Health Survey.
Note: *Estimate is based on small numbers, so values should be interpreted with caution; ** Estimate is suppressed due to insufficient data

[23] New York City Department of Health and Mental Hygiene. *Adults Reporting Mold in the Home*, http://a816-dohbesp.nyc.gov/IndicatorPublic/VisualizationData.aspx?id=2101,719b87,36,Summarize

The scatterplots below illustrate the positive correlations between the age-adjusted rate for asthma ED visits and percent of homes with leaks (Figure 14) and percent of adults reporting mold in homes (Figure 15), respectively. Each dot on the plot represents a UHF-42 area in NYC.

Figure 14: Percent of Homes with Leaks and Age-Adjusted Rate of Asthma ED Visits in NYC, by UHF-42



Data Source: 2014 New York City Housing and Vacancy Survey
New York State Statewide Planning and Research Cooperative System (SPARCS)

Figure 15: Percent of Adults Reporting Mold in the Home and Age-Adjusted Rate of Asthma ED Visits in NYC, by UHF-42

Data Source: 2012 New York City Community Health Survey
New York State Statewide Planning and Research Cooperative System (SPARCS)

Maintenance Deficiencies in the Home

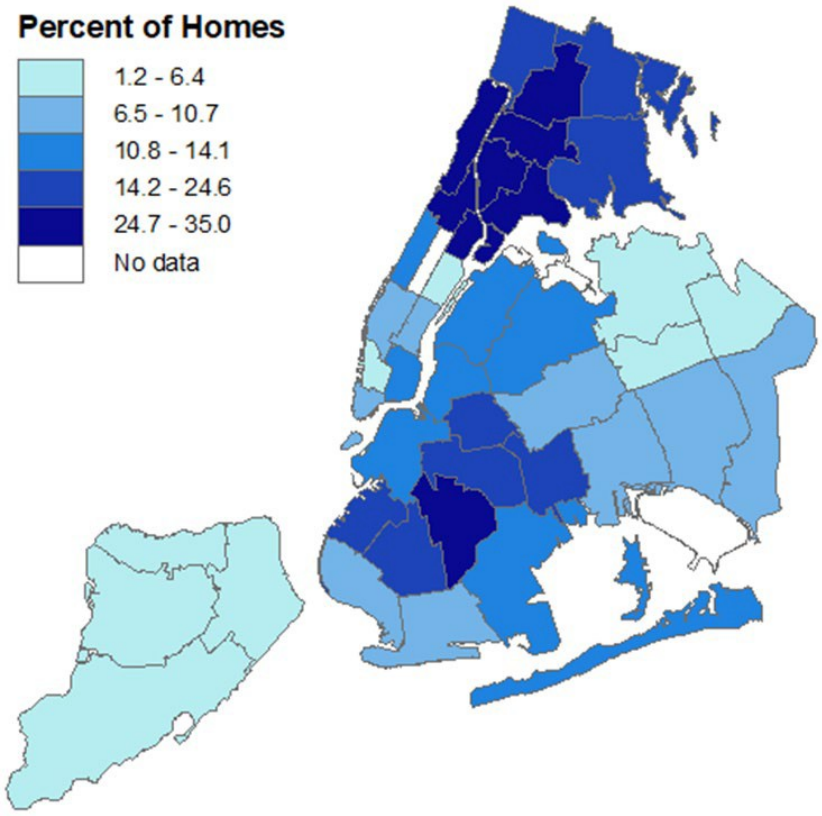
Residents in homes with poor housing quality, including structural damage, maintenance deficiencies, and a lack of amenities, have been observed to have higher rates of asthma.[24, 25, 26] One study in NYC found an increase in the presence of asthma triggers such as mouse and cockroach allergens in homes with multiple building violations.[27] In another study, an increase in the number of housing code violations in an area was found to be associated with an increase in rates of asthma among residents of the area in comparison to areas with fewer housing violations.[28] In addition to housing quality, data from the 2015 American Housing Survey

[24] Pacheco, C. M. et al. Homes of low-income minority families with asthmatic children have increased condition issues. Allergy Asthma Proc 35, 467-474, (2014).
[25] Northridge, J., Ramirez, O. F., Stingone, J. A. & Claudio, L. The role of housing type and housing quality in urban children with asthma. Journal of Urban Health 87, 211-224 (2010).
[26] Hughes, H. K., Matsui, E. C., Tschudy, M. M., Pollack, C. E. & Keet, C. A. Pediatric Asthma Health Disparities: Race, Hardship, Housing, and Asthma in a National Survey. Academic Pediatrics 17, 127-134, (2017).
[27] Rosenfeld, L., Rudd, R., Chew, G. L., Emmons, K. & Acevedo-Garcia, D. Are neighborhood-level characteristics associated with indoor allergens in the household? *J Asthma* **47**, 66-75, (2010).
[28] Beck, A. F., Huang, B., Chundur, R. & Kahn, R. S. Housing code violationdensity associated with emergency department and hospital use by children with asthma. *Health affairs* **33**, 1993-2002 (2014).

collected information on school-age children. Those findings showed renter-households with school-age children are more likely than owner-households to have exposures to asthma triggers including smoke, musty smells, mold, leaks, and pests in their homes. Renter households with these exposures were also more likely to have at least one child with asthma.[29] Although not conclusive, this finding of fewer deficiencies in owner-households could be due to the ability of a homeowner to address maintenance or structural issues and reduce exposure to triggers in a timely manner.

The NYC HVS collects information on other maintenance deficiencies including heating equipment breakdown, need for additional heating, cracks/holes in the walls, ceilings or floors, broken plaster/peeling paint (larger than 8½ x 11 inches), and toilet breakdowns. The map in Figure 16 displays percent of homes reporting three or more maintenance deficiencies in the 2011 NYC HVS. Citywide about 15% of homes reported three or more deficiencies. The highest percent of these reports were seen in the Bronx (25.6%) and Brooklyn (17.3%). The Crotona-Tremont neighborhood in the Bronx had the highest percentage of homes reporting 3 or more maintenance deficiencies (35%) followed by the High Bridge – Morrisania (33.3%) and East Harlem neighborhoods (31.3%) also in the Bronx. Lowest percentage of homes with 3 or more maintenance deficiencies were reported in the South Beach-Tottenville neighborhood (1.2%) in Staten Island and Bayside-Little Neck in Queens. The linear trend in Figure 17 indicated a positive correlation between neighborhoods with a higher percent of homes with three or more maintenance deficiencies had a higher asthma ED visit rate.

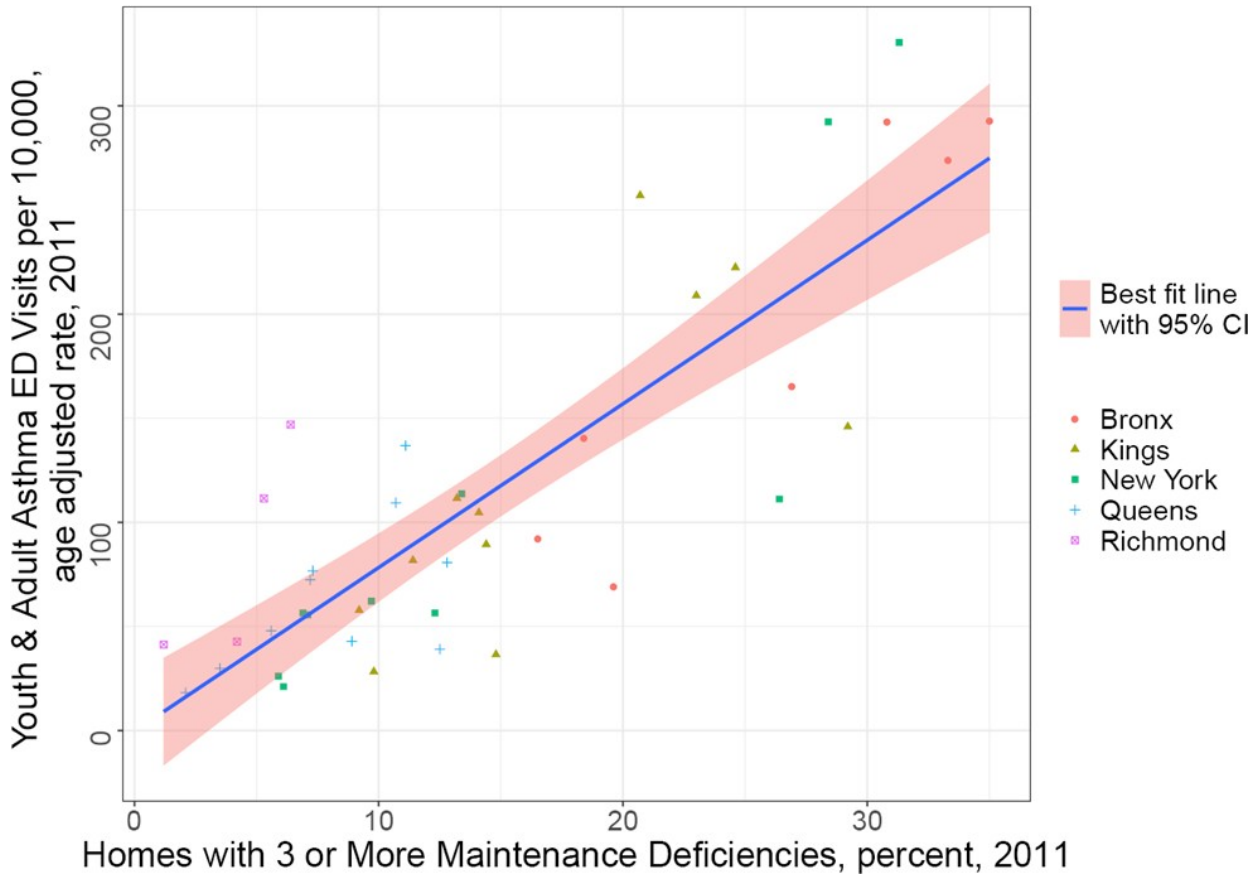
Figure 16. Percent of homes reporting three or more maintenance deficiencies in 2011, by UHF-42 Neighborhoods in NYC



Data Source: 2011 New York City Housing and Vacancy Survey

[29] Ganesh, B., Skopec, C. P. S. L. & Zhu, J. The Relationship between Housing and Asthma among School-Age Children (Washington, DC: Urban Institute, 2017).

Figure 17. Scatterplot with Percent homes reporting three or more maintenance deficiencies in 2011 by Asthma Rate among Youth and Adults, by UHF-42 in NYC.



Data Source: 2011 New York City Housing and Vacancy Survey
New York State Statewide Planning and Research Cooperative System (SPARCS)

Pests in the Home

Cockroaches: Cockroach debris, including droppings, and body parts can trigger asthma attacks in individuals who are sensitized to cockroach allergen. Signs of cockroach infestation include observable debris, or a noticeable odor detected even when there are no visual signs of their presence.[30] Cockroaches are generally nocturnal, so a cockroach seen during the day may be a sign of a major infestation. Cockroach allergens can remain long after the cockroaches have been removed. Approximately one fifth of currently roach-free homes contain detectable levels of cockroach allergens.[31] Cockroach allergens are a major risk factor for asthma severity and

[30] Centers for Disease Control and Prevention& U.S. Department of Housing and Urban Development. Healthy housing reference manual. (US Department of Health and Human Services, Atlanta, 2006).
[31] Institute of Medicine. Clearingthe Air: Asthmaand Indoor Air Exposures. (National Academies Press, Washington DC, 2000).

wheezing among inner city children. [32] Higher levels of exposure are associated with higher incidence of cockroach sensitization and, among children sensitive to cockroaches, with increased asthma severity and earlier onset of asthma.[33]

The US Environmental Protection Agency (EPA) identifies cockroaches in the home or school as a trigger for respiratory symptoms and asthma exacerbations among children. [34] The IOM determined that specific cockroach allergens induced respiratory distress and worsened asthma in people sensitive to cockroaches.[35] In a multisite study funded by the National Institute of Allergy and Infectious Diseases (NIAID) that included two NYC-based sites, researchers identified cockroaches as the main indoor asthma trigger.[36] The NYC Neighborhood Asthma and Allergy Study reported that homes in neighborhoods with high asthma prevalence had significantly higher prevalence of cockroaches in the home than homes in neighborhoods with low asthma prevalence.[37] In another study, residents of public housing were over three times more likely to report cockroaches in the home than residents of other housing types.[38]

Data from the 2014 NYC HVS were used to map the percent of homes in each UHF-42 neighborhood that reported seeing at least one cockroach daily over the last month (Figure 18).[39] Neighborhoods with the highest percentages of homes with daily cockroach sightings tended to be in the Bronx, notably Crotona-Tremont (45%), High Bridge-Morrisania (43%), and Hunts Point-Mott Haven (40%), while the lowest percentage was South Beach-Tottenville (1%) on Staten Island and some neighborhoods in eastern Queens. The trend line below (Figure 19) shows the relationship between reported cockroach sightings and ED visit asthma rates, indicating that UHF-42 neighborhoods reporting a higher percentage of homes with cockroaches tend to have higher asthma ED visits among youth and adults.

[32] Togias, A., Fenton, M. J., Gergen, P. J., Rotrosen, D. & Fauci, A. S. Asthma in the inner city: the perspective of the National Institute of Allergy and Infectious Diseases. *J Allergy Clin Immunol* **125**, 540-544, (2010).

[33] Centers for Disease Control and Prevention& U.S. Department of Housing and Urban Development. Healthy housing reference manual. (US Department of Health and Human Services, Atlanta, 2006).

[34] US Environmental Protection Agency. America's Children and the Environment. Report EPA 240-R-13-001,(2013).

[35] Institute of Medicine. Clearingthe Air: Asthmaand Indoor Air Exposures. (National Academies Press, Washington DC, 2000).

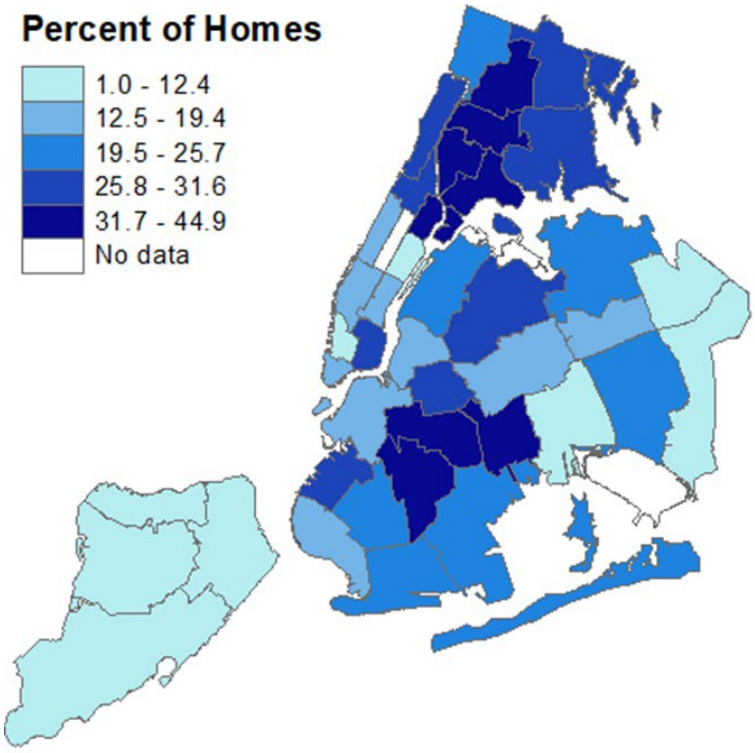
[36] Rosenstreich, D. L. *et al.* The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. *N Engl J Med* **336**, (1997).

[37] Olmedo, O. *et al.* Neighborhood differences in exposure and sensitization to cockroach, mouse, dust mite, cat, and dog allergens in New York City. *J Allergy Clin Immunol* **128**, 284-292 e287 (2011).

[38] Northridge, J., Ramirez, O. F., Stingone, J. A. & Claudio, L. The role of housing type and housing quality in urban children with asthma. *J Urban Health* **87**, 211-224, (2010).

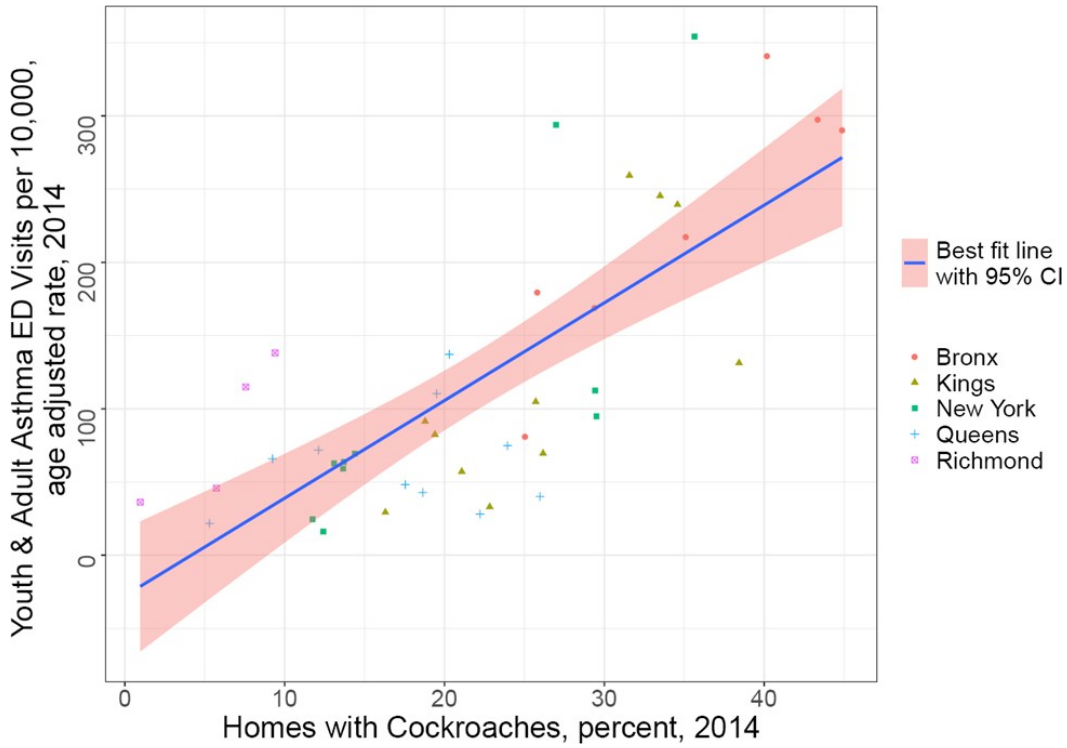
[39] New York City Department of Health Environmental & Health Data Portal. *Cockroaches: Homes with Cockroaches*, <http://a816-dohbesp.nyc.gov/IndicatorPublic/VisualizationData.aspx?id=107,719b87,8,Summarize> (2014).

Figure 18. Percent of Homes reporting Cockroaches in 2014, by UHF42 Neighborhoods in NYC



Data Source: 2014 New York City Housing and Vacancy Survey

Figure 19. Scatterplot of Percent of homes reporting cockroaches, by Asthma rate among Youth and Adults, 2014 in UHF-42 neighborhoods, NYC



Data Source: 2014 New York City Housing and Vacancy Survey
New York State Statewide Planning and Research Cooperative System (SPARCS)

Rodents: Rodent allergens, from rats, mice and pets like hamsters, also play a role in the risk of asthma. [40, 41, 42] Signs of rodent infestation include droppings, hair, nest materials, urine spots, and gnaw marks.[43] The urine, saliva, and skin of rats and mice contain allergens,[44] with urine being the main source of rodent allergens.[40] Attached to very small dust particles, these allergens can remain airborne for over an hour at a time and trigger asthma in people with rodent allergies or sensitivities.[40,44] Studies have shown that increased exposure to rodent allergens is associated with increased mouse sensitization and asthma morbidity. [42, 45] Inner-city children who were sensitized and exposed to rat allergen in their home had a higher number of asthma-related hospitalizations and unscheduled medical visits than children that were not.[42]

According to the 2015 American Housing Survey, 15.4% of homes in the NYC metro area reported signs of rodents in the last 12 months.[46] The NYC Neighborhood Asthma and Allergy Study found that higher levels of mouse allergens were associated with lower neighborhood income. [47]

The map in Figure 20 shows the percent of households in each UHF-42 area that reported mice or rats in their building in the past 90 days. The neighborhoods with the highest percentages of homes reporting mouse sightings were in the Bronx, including High Bridge-Morrisania (44%), Crotona-Tremont (44%), and Hunts Point-Mott Haven (39%), while the lowest was South Beach-Tottenville (1%) on Staten Island and eastern parts of Queens. The trend line in Figure 21 shows a positive correlation between asthma ED visit rates and mouse sightings by UHF-42 area indicating that an increase in allergen exposure could be related to an increase in asthma ED visits.

[40] Phipatanakul, W. Rodent allergens. *Curr Allergy Asthma Rep* **2**, 412-416 (2002)

[41] Matsui, E. C. Management of rodent exposure and allergy in the pediatric population. *Current allergyandasthma reports* **13**, 681-686 (2013).

[42] Phipatanakul, W., Eggleston, P. A., Wright, E. C., Wood, R. A. & National Cooperative Inner-City Asthma, S. Mouse allergen. II. The relationship of mouse allergen exposure to mouse sensitization and asthma morbidity in inner-city children with asthma. *J Allergy Clin Immunol* **106**, 1075-1080 (2000).

[43] Centers for Disease Control and Prevention& U.S. Department of Housing and Urban Development. Healthy housing reference manual. (US Department of Health and Human Services, Atlanta, 2006).

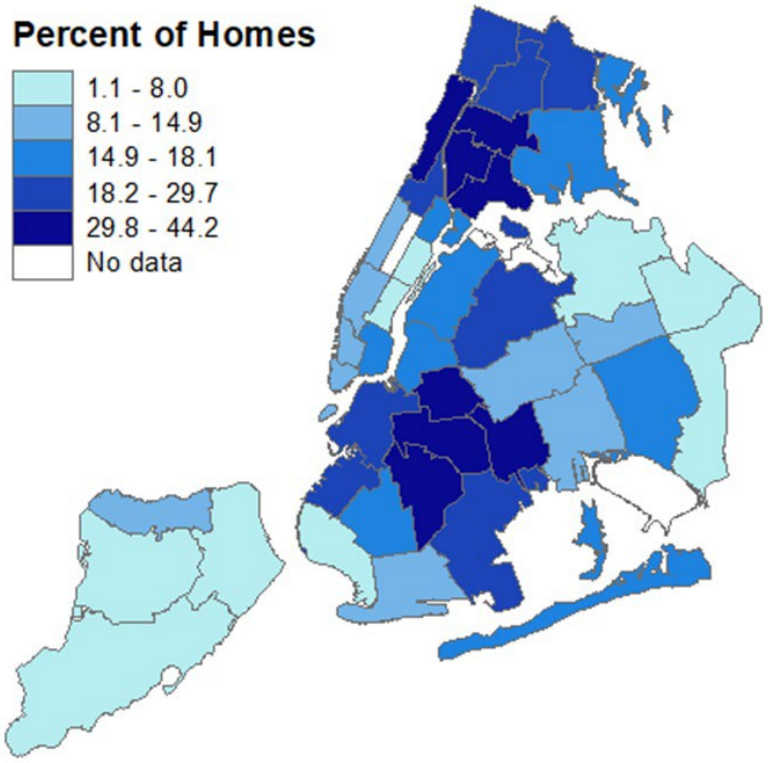
[44] Institute of Medicine. Clearingthe Air: Asthmaand Indoor Air Exposures. (National Academies Press, Washington DC, 2000).

[45] Pongracic, J. A., et al. Effect of mouse allergen and rodent environmental intervention on asthma in inner-city children. *Annals of Allergy, Asthma & Immunology* **101**, 35-41, (2008).

[46] Brown, A. A. HUD and Census Bureau release American Housing Survey results for 25 metro areas (U.S. Department of Housing and Urban Development (HUD), Washington, 2017).

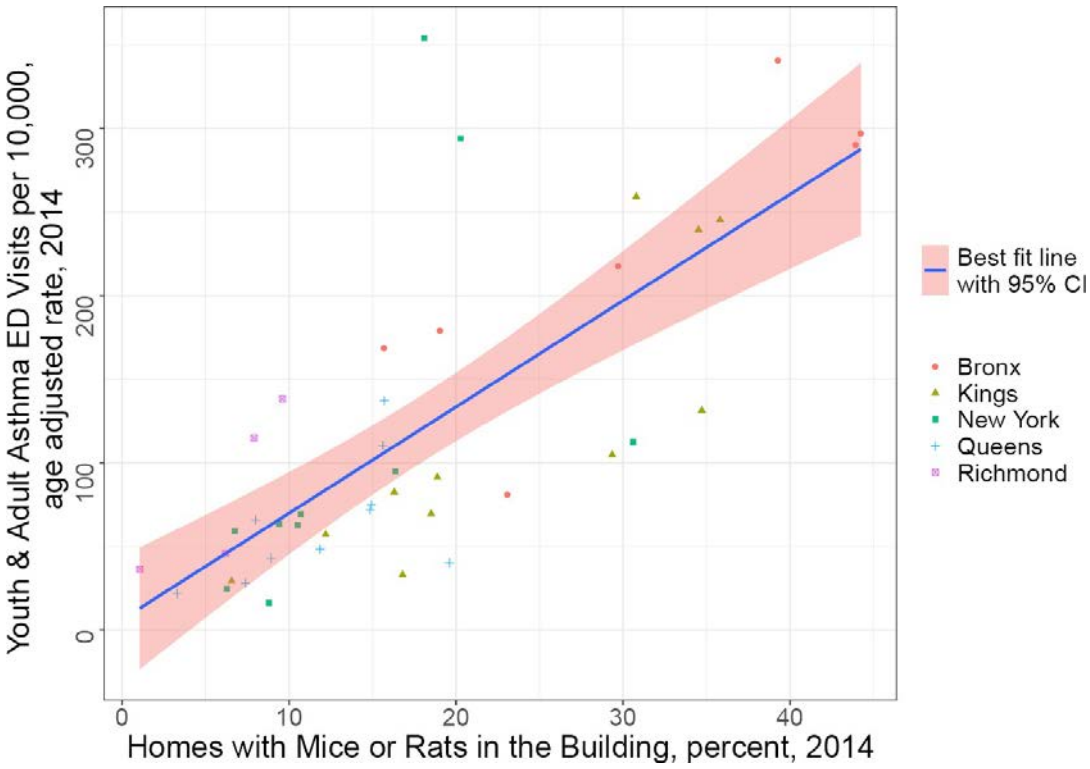
[47] Olmedo, O. *et al.* Neighborhood differences in exposure and sensitization to cockroach, mouse, dust mite, cat, and dog allergens in New York City. *J Allergy Clin Immunol* **128**, 284-292 e287, (2011).

Figure 20. Percent of homes reporting mice or rats in the building, in 2014, by UHF-42 Neighborhoods in NYC



Data Source: 2014 New York City Housing and Vacancy Survey

Figure 21. Percent of homes reporting mice or rats in the building by asthma rate among youth and adults, 2014 in UHF-42 neighborhoods, in NYC



Data Source: 2014 New York City Housing and Vacancy Survey; New York State Statewide Planning and Research Cooperative System (SPARCS)

Commercial Applications of Pesticide Aerosol Products Containing Piperonyl Butoxide

Measures to reduce or prevent rodent and pest infestations may include the use of certain pesticides, some of which may contain asthmagens (substances that can cause asthma). The NYS Pesticide Reporting Law, enacted in 1996, requires commercial applicators to maintain a record of each pesticide application. The record includes the street address of the application; including the County and ZIP Code, the EPA Registration number for each product applied and the quantity, in pounds or gallons, of each product applied. The data are entered into a database and are made publicly available at the ZIP Code and County levels on the Pesticide Sales and Use Reporting (PSUR) webpage maintained by the Cornell University Cooperative Extension. It is important to note that applications of pesticides by property owners are not captured in this database and that these types of applications are likely greater in number than the commercial applications reported.

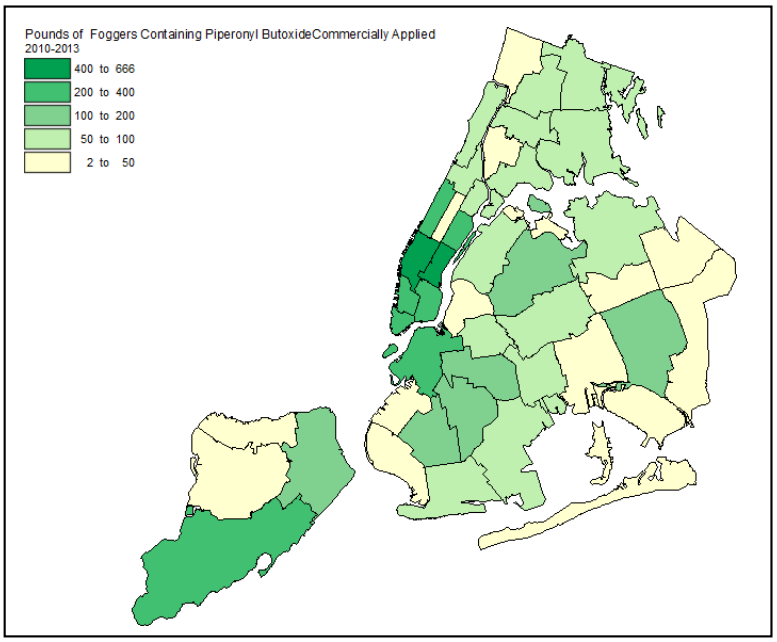
Tables containing ZIP Code level commercial pesticide applications data for the years 2010 through 2013 were downloaded from the PSUR website. Tables from the EPA Pesticide Product Information System (PPIS) that contain information including product name, formulation (granular, pressurized liquid, etc.), and active ingredient information were also downloaded and combined with the PSUR tables in a Microsoft Access database.

Piperonyl butoxide (PBO) is defined by the EPA as a pesticide active ingredient that acts as a synergist, or chemical that while lacking pesticidal properties of its own, enhances the pesticidal properties of other active ingredients. PBO is combined with many pyrethrin based insecticide formulations. An EPA review of data[48] from poison control centers found that respiratory symptoms resulting from exposure to pesticide products were more likely to be reported when the products contained PBO. The Access database was used to identify pesticide products that contain PBO and are packaged in pressurized aerosol spray cans. Aerosol products were selected because of their high potential for inhalation exposure and because the quantities applied are not as frequently misreported in the PSUR database as are other pesticide formulation types. Initially, products marketed as total release foggers were assessed. Total release foggers, also known as bug bombs, are pesticide products containing aerosol propellants that are designed to fumigate an area by releasing their entire contents over a short period of time. These products are used around homes and workplaces to kill cockroaches, fleas, and other insect pests in buildings. The data was also used to identify other types of pressurized aerosol spray products that contain PBO. In each case, the total pounds of products commercially applied in each of the UHF-42 regions was determined. It is important to note that the total quantity of active ingredients in the products applied, including PBO, are much less than 1% of the total quantities of the products applied. Products often contain materials to improve the delivery of the active pesticidal ingredients that do not have pesticidal activity themselves. Looking at pesticide products and applications can indicate three potential asthma triggers, the pest, PBO, and airborne droplets and particles from the fogger. The results of the data base queries are presented in Figures 21 & 22. In general, the UHF areas with the highest use of commercially applied pesticides containing

[48] Reregistration Eligibility Decision for Piperonyl Butoxide (PBO). US EPA. Accessed on Mar 23,2021. https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/red_PC-067501_14-Jun-06.pdf

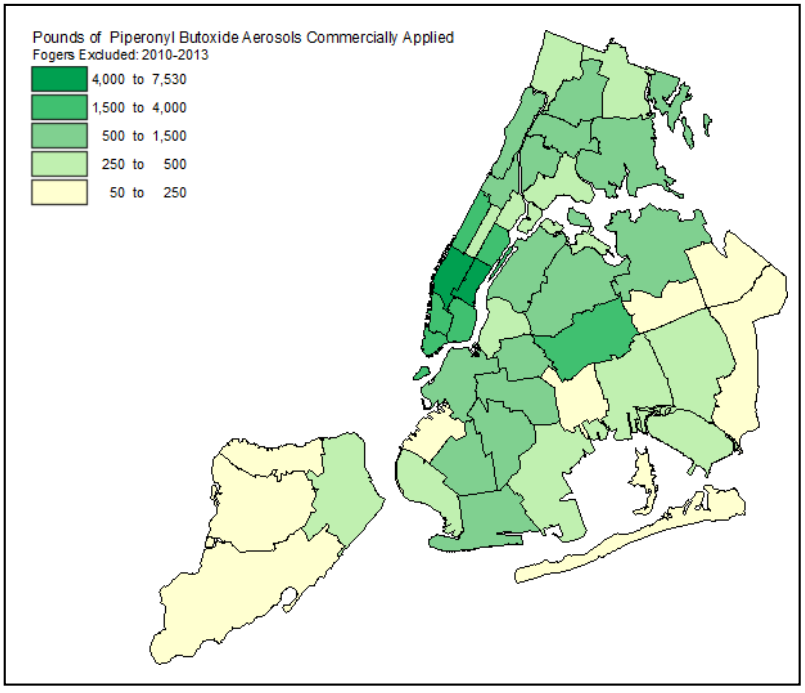
POB do not tend to be the same areas where asthma rates are highest. The absence of a trend for pesticide foggers to be associated with asthma burden could be due to reduced exposures to the pesticide from following label instructions, reductions in insect related allergens, or incomplete data on pesticide use.

Figure 21. Pounds of Piperonyl Butoxide Containing Total Release Foggers Commercially Applied*: 2010 - 2013



*NYS Pesticide Sales & Use Database

Figure 22. Pounds of Piperonyl Butoxide Containing Aerosol Products (Excluding Foggers) Commercially Applied*: 2010 - 2013



*NYS Pesticide Sales & Use Database

Second-Hand Smoke

Tobacco or other smoke can be an asthma trigger because it contains gases and particles that irritate the linings of the airway and lungs.[49, 50] Secondhand smoke (SHS) exposure can result from inhalation of mainstream smoke (smoke exhaled by the smoker) or side stream smoke that enters the environment from the burning of a cigarette, cigar or pipe.[51, 52] Exposure to SHS can occur from living, working, traveling, and communicating in-person with a smoker. In multiunit buildings, SHS can result when smoke from homes of smokers or outdoor spaces used by smokers drifts into building hallways and/or into homes with non-smoking residents.[52, 53] SHS exposure has been linked to increased frequency and severity of asthma episodes, poor asthma control and increased asthma-related medical visits among all age groups.[54, 55, 56] SHS can lead to decreased lung function and symptoms of airway inflammation and asthma, such as cough, wheeze, and increased mucus production.

The map in Figure 23 displays the percent of adults who reported the presence of SHS, all or most of the time, in their homes for each UHF-42 neighborhood (note that estimates in this map are based on small numbers so should be interpreted with caution). Citywide about 5% of adults reported SHS at home. The Rockaway neighborhood in Queens had the highest percent of adults reporting SHS (11.3%) while the Upper West Side neighborhood in Manhattan reported the lowest percent (1.4%). Other neighborhoods in Queens (Ridgewood-Forest Hills), the Bronx (Crotona – Tremont, High Bridge – Morrisania, Hunts Point - Mott Haven) and Manhattan (Central Harlem - Morningside Heights) also reported higher percentages of adults with SHS (8.8% or more) relative to the citywide proportion. UHF-42 neighborhoods with a higher percent of youths and adults reporting SHS showed a higher rate of asthma ED visits, as seen in the image below (Figure 24).

[49] Centers for Disease Control and Prevention& U.S. Department of Housing and Urban Development. Healthy housing reference manual. (US Department of Health and Human Services, Atlanta, 2006).

[50] Centers for Disease Control and Prevention Office on Smoking and Health. National Center for Chronic Disease Prevention and Health Promotion. Secondhand Smoke (SHS) Facts. https://www.cdc.gov/tobacco/data_statistics/fact_sheets/secondhand_smoke/general_facts/index.htm (2018).

[51] Conrad, L. & Perzanowski, M. S. The Role of Environmental Controls in Managing Asthma in Lower-Income Urban Communities. Clinical Reviews in Allergy & Immunology, (2019).

[52] King, B. A., Travers, M. J., Cummings, K. M., Mahoney, M. C. & Hyland, A. J. Secondhand smoke transfer in multiunit housing. Nicotine & tobacco research: official journal of the Society for Research on Nicotine and Tobacco 12, 1133-1141, (2010).

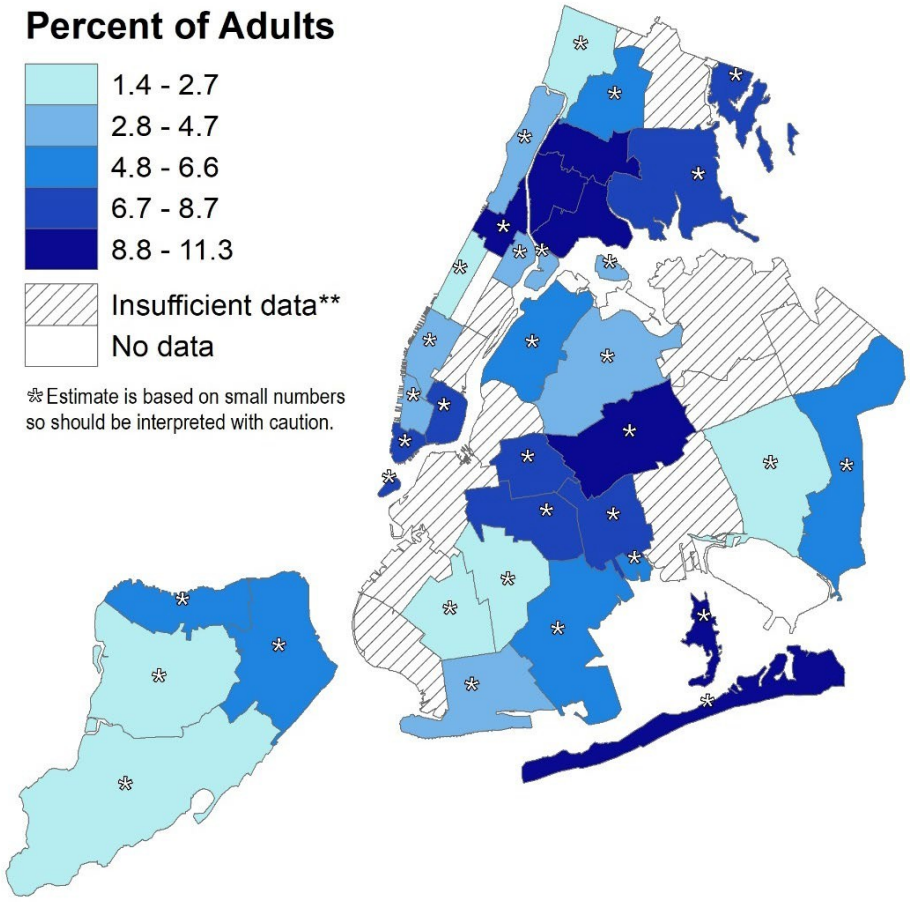
[53] Perlman, S. E. et al. Exposure to Secondhand Smoke Among Nonsmokers in New York City in the Context of Recent Tobacco Control Policies: Current Status, Changes Over the Past Decade, and National Comparisons.

[54] U.S. Department of Health and Human Services. The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General. (U.S. Department of Health and Human Services, CDC, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2006).

[55] Hollenbach, J. P., Schifano, E. D., Hammel, C. & Cloutier, M. M. Exposure to secondhand smoke and asthma severity among children in Connecticut. PloS one 12, e0174541, (2017).

[56] Neophytou, A. M. et al. Secondhand smoke exposure and asthma outcomes among African-American and Latino children with asthma. Thorax 73, 1041-1048, (2018).

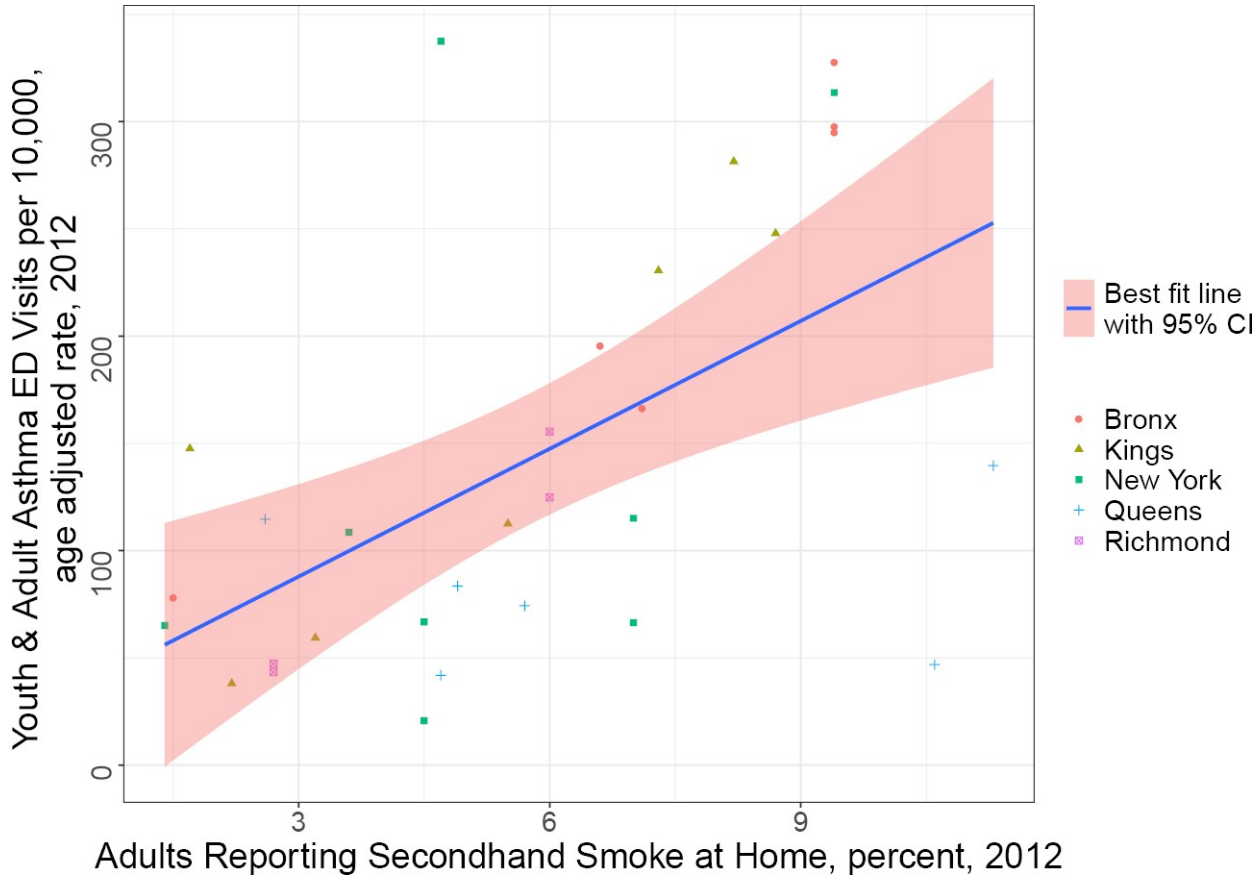
Figure 23. Percent of adults reporting secondhand smoke at home in 2012, by UHF-42 neighborhoods in NYC



Source: New York City Community Health Survey
** Estimate is supressed due to insufficient data.

Data Source: 2012 New York City Community Health Survey.
Note: *Estimate is based on small numbers, so values should be interpreted with caution; ** Estimate is suppressed due to insufficient data

Figure 24. Scatterplot of percent adults reporting secondhand smoke at home by asthma rates among youth and adults in 2012, by UHF42 neighborhoods, in NYC



Data Source: 2012 New York City Community Health Survey
New York State Statewide Planning and Research Cooperative System (SPARCS)

Public Housing

Public housing and rental assistance programs are often established by local housing agencies to provide safe rental housing for eligible low-income families, the elderly, and persons with disabilities. The US Department of Housing and Urban Development (HUD) provides the NYC Housing Authority (NYCHA) with federal aid, technical and professional assistance in planning, developing, and managing these developments. NYCHA's mission is to provide safe, affordable housing, and to facilitate access to social and community services to low- and moderate-income New Yorkers.[57] Through NYCHA, qualifying residents contribute 30% of the household income towards rent while HUD subsidizes the remainder. NYCHA currently houses over 400,000 New Yorkers in 326 Public Housing Authority (PHA) developments across the five boroughs. Another 235,000 residents receive subsidized rental assistance in private homes through NYCHA-administered Section 8 housing. While federally-assisted housing provides eligible residents affordable housing, multiple studies have shown higher rates of asthma among these residents in

[57] City of New York. *About NYCHA*, https://www1.nyc.gov/site/nycha/about/about-nycha.page (2019)

comparison to the general population.[58, 59, 60, 61, 62] Previous studies frequently associate poorer indoor air quality, SHS exposure and allergens, and limited access to health care with increased asthma risk. An evaluation of Boston Behavioral Risk Factor Surveillance System (BRFSS) surveys found that public housing is frequently linked to poorer indoor housing quality and that asthma prevalence among residents of PHAs and rental assistance units was two times higher than that of non-residents.[61] In NYC, the Clean Air Survey was conducted among a random sample of 1,200 adult residents of NYCHA to assess experiences with exposure to SHS and associated health outcomes .[63] Results were compared to the annual NYC CHS. NYCHA residents were about twice as likely to report having asthma compared to CHS respondents. In addition, more than a third of NYCHA residents (34%) reported having one or more children with asthma compared to one-eighth (13%) among CHS respondents. It should be noted that there may be additional variation across different public housing locations. A study showed that rates of preventable hospitalizations in NYC varied by public housing development and condition of the building. [64] Compared to citywide rates, and rates among people living in low-income non-public housing areas, the preventable hospitalization rates for asthma in this study was higher among public housing residents.

Although comprehensive data summarizing differences in the prevalence of asthma triggers and allergens inside or outside of public housing were not available, staff used available data to better understand possible differences in asthma burden between these groups. A table summarizing the data used to develop the maps and charts in this section can be found in Appendix B. In Figure 25, the yellow markings on the map represent NYCHA development footprints and the green-blue shading represents the percent of UHF-42 neighborhood population that lives in NYCHA homes in 2016.[65] About 415,000 people, comprising 5% of the total NYC population, lived in NYCHA developments in 2016, including Section 8 Transition and Public Housing Units in the Tax Credit Developments and Non-Tax Credit Developments.[66]

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[58] Gutierrez Kapheim, M., Ramsay, J., Schwindt, T., Hunt, B. R. & Margellos-Anast, H. Utilizing the Community Health Worker Model to communicate strategies for asthma self-management and self-advocacy among public housing residents. Journal of Communication in Healthcare 8, 95-105, (2015).

[59] Mason, J., Wheeler, W. & Brown, M. J. The economic burden of exposure to secondhand smoke for child and adult never smokersresidingin U.S. public housing. Public Health Rep 130, 230-244, (2015).

[60] Perovich, L. J. et al. Reporting to parents on children's exposures to asthma triggers in low-income and public housing, an interview-based case study of ethics, environmental literacy, individual action, and public health benefits. Environmental Health 17, 48, (2018).

[61] Mehta, A. J., Dooley, D. P., Kane, J., Reid, M. & Shah, S. N. Subsidized Housing and Adult Asthma in Boston, 2010-2015. American journal of publichealth 108, 1059-1065, (2018).

[62] Northridge, J., Ramirez, O. F., Stingone, J. A. & Claudio, L. The role of housing type and housing quality in urban children with asthma. Journal of Urban Health 87, 211-224 (2010).

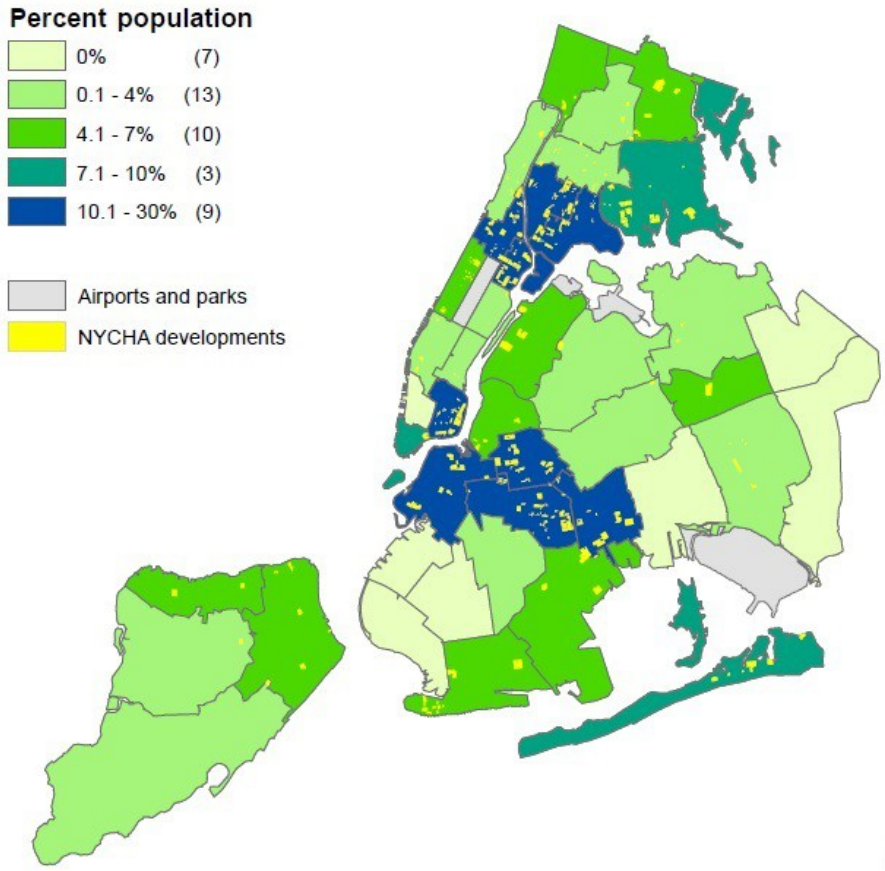
[63] Farley, S. M., Schroth, K. R. J., Curtis, C. J. & Angell, S. Evidence of Support for Smoke-Free Public Housing Among New York City Residents. *Public Health Rep* **131**, 2-3, (2016).

[64] Yim, B. *et al*. Disparities in preventable hospitalizations among public housing developments. *American joumal of preventive medicine* **56**, 187-195 (2019).

[65] City of New York. *About NYCHA*, <https://www1.nyc.gov/site/nycha/about/about-nycha.page> (2019).

[66] New York City Housing Authority. New York City Housing Authority Developments Data Book (NYC OpenData, New York City, 2016) https://data.cityofnewyork.us/Housing-Development/Map-of-NYCHA-Developments/i9rv-hdr5

Figure 25. Percent of UHF42 neighborhood population living in New York City Housing Authority assisted housing, 2016 in NYC.



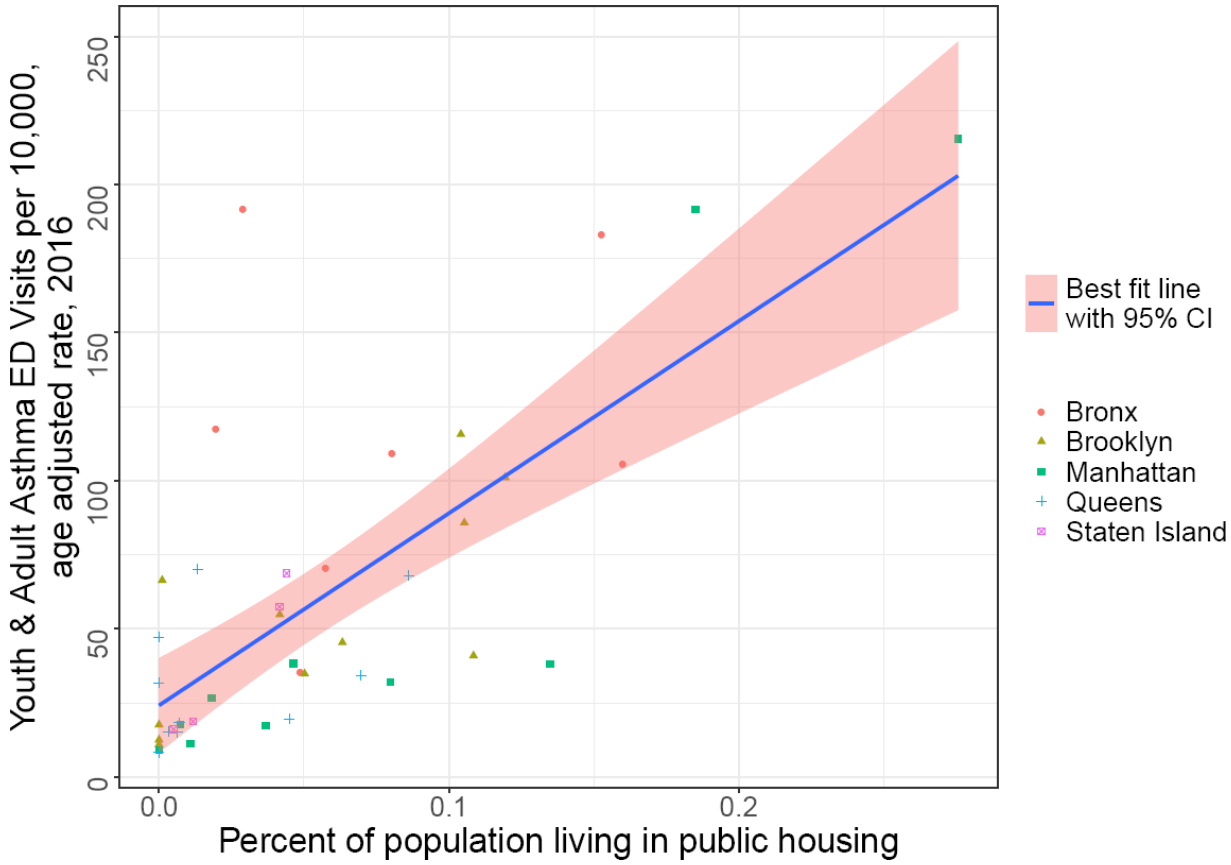
Data Source: 2016 New York City Housing Authority (NYCHA) Development Data Book

Using New York State Statewide Planning and Research Cooperative System (SPARCS) data, from 2008 to 2012, asthma ED visits for people in the five boroughs of NYC were analyzed. There were 562,552 asthma visits (all ages) with an asthma ED visit rate of 138 per 10,000. The scatterplot below (Figure 26) shows the overall asthma ED visit rate by UHF-42 plotted against the percent of population in the UHF-42 that are living in public housing. This plot suggests that UHF-42 neighborhoods with a higher proportion of the population living in public housing tend to have higher asthma ED visit rates.

As an additional step, asthma ED visits for residents living in and out of NYCHA developments were examined more closely. Of total NYC asthma ED visits for 2008-2012, approximately 46,000 asthma ED visits (8.2%), occurred among residents of public housing. For NYC overall, the asthma ED visit rate among residents of public housing was about 230 per 10,000, or 1.7 times higher than the asthma ED visit rate of 133 per 10,000 population among residents living outside of public housing. However, this finding was not consistent for all UHF-42 neighborhoods. The map in Figure 27 compares asthma ED visit rates among public housing residents with those among people living outside public housing for each UHF-42 neighborhood. The color shading for UHF-42

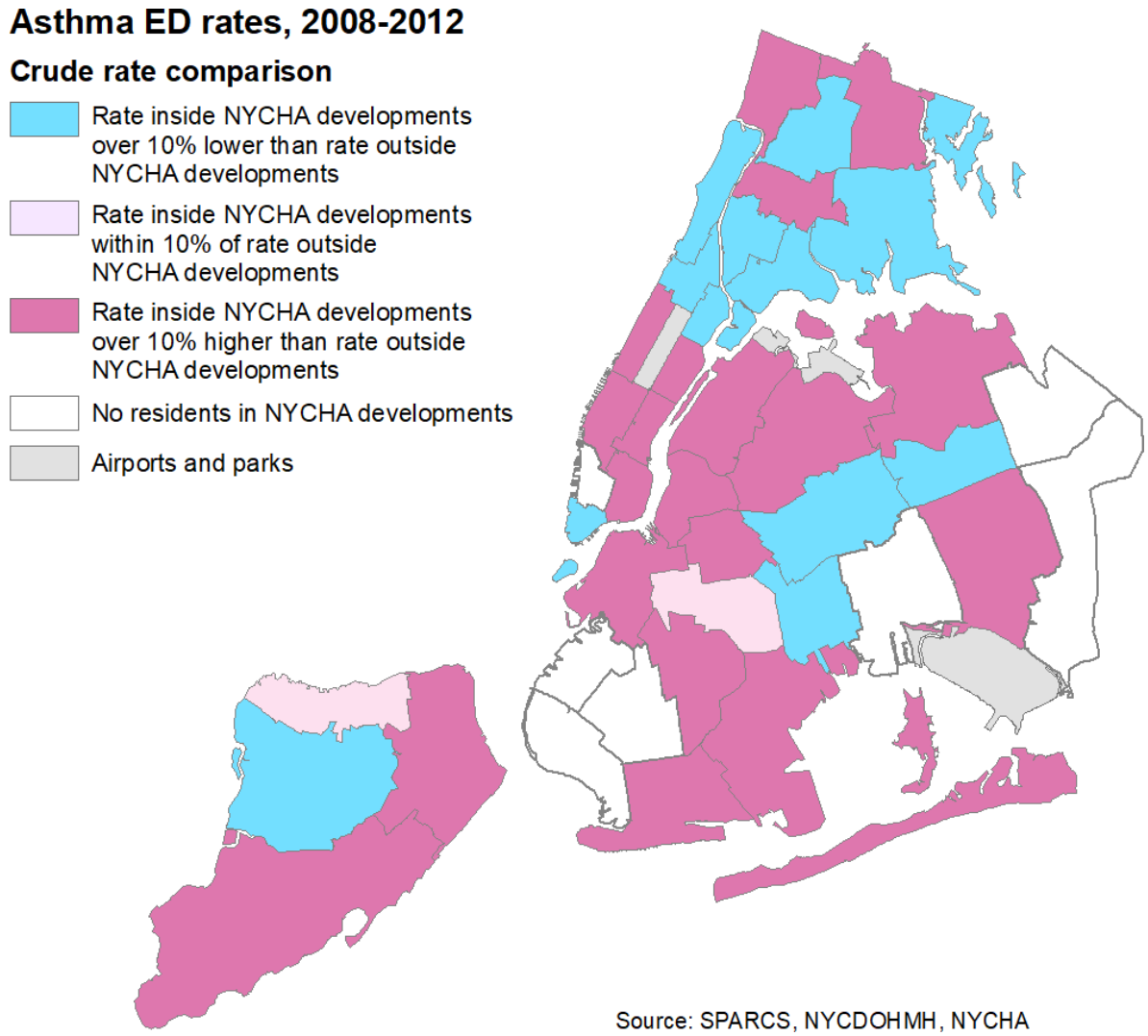
neighborhoods represents the magnitude and direction of the difference between the two asthma rates. In some UHF-42 neighborhoods, the asthma ED visit rates were higher among people living outside of public housing. This suggests that there may be factors other than, or in addition to, living in public housing that are driving asthma ED visitation rates in certain neighborhoods of NYC.

Figure 26. Scatterplot of asthma emergency department (ED) visit rate by percent of UHF42 population living in public housing, 2016, in NYC



Data Source: 2016 New York City Housing Authority (NYCHA) Development Data Book
New York State Statewide Planning and Research Cooperative System (SPARCS)

Figure 27. Comparison of asthma emergency department visit rates between residents living in public housing to those outside of NYCHA developments, by UHF-42 neighborhood.



Data Source: 2016 New York City Housing Authority (NYCHA) Development Data Book
New York State Statewide Planning and Research Cooperative System (SPARCS)

Workplace Asthma Triggers

Many occupations and workplace exposures can contribute to asthma onset and exacerbation. Unlike air pollution, datasets that would provide information on how these settings may contribute to differences in asthma burden across the five boroughs are not available. The Association of Occupational and Environmental Health Clinics (AOEC) maintains a list of asthmagens. A link to the AOEC website and more information about which occupations may be at risk for work-related asthma can be found on the Department Occupational Lung Disease web page: https://www.health.ny.gov/environmental/workplace/lung_disease_registry/oldr_fact_sheet.htm#asthma.

Review of Outdoor Air Quality, Triggers and Allergens

Air monitoring

The DEC maintains a network of air monitors in locations across the five boroughs (Appendix C, Figure C1). The EPA has set National Ambient Air Quality Standards for six criteria pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter; these pollutants along with other volatile organic compounds (VOCs) are measured by the DEC air monitoring network. Criteria air pollutants such as nitrogen dioxide, sulfur dioxide, ozone and particulate matter are associated with incident asthma and/or exacerbation of asthma.[67]

For nitrogen dioxide, sulfur dioxide and particulate matter, the air concentrations across NYC have been declining over the past 20 years (Appendix C, Figures C2-C4). The trend for ozone air pollution is more complicated. Ozone is not a pollutant that is directly emitted. It forms in the air through chemical reactions involving VOCs, nitrogen oxides, sunlight, and heat. Ozone concentrations vary by season and by year, are influenced by weather, and by pollution sources from other areas of the country. Historically, ozone levels were elevated in hot, sunny, summer weather and declined and remained low during the colder months. The current trend appears to show a rise in average annual ozone levels from October to March (Appendix C, Figure C5), with summer levels variable, but also trending upward (Appendix C, Figure C6). The variability and trend in air pollutants are likely due to changes in precursor pollutants (pollutants that react to form ozone).

In addition to air monitoring by NYS, the NYC DOHMH and Queens College have partnered since 2008 to conduct the New York City Community Air Survey (NYCCAS) by using monitors to collect air pollution measurements at around 100 locations across NYC to learn how air quality differs throughout NYC. The results from the collaborative effort are summarized in fact sheets and in a series of reports found on the NYC DOHMH website (https://www1.nyc.gov/site/doh/data/data-publications/air-quality-nyc-community-air-survey.page).

Regulated facilities

In addition to maintaining a network of air monitoring sites, DEC also issues permits and registrations for businesses and facilities based on the amount and type of pollutants they emit. Some of these pollutants are recognized as workplace asthmagens, or respiratory irritants that may contribute to asthma burden. Major sources of pollution, from a regulatory perspective, are required to obtain a permit under Title V of the Clean Air Act. The EPA defines the threshold for major source to be 100 tons per year of a criteria pollutant. The threshold is lower for areas where the monitored criteria pollutant is above the National Ambient Air Quality Standards established by the EPA. These areas are defined as non-attainment areas. Facility owners whose operations emit hazardous air pollutants (HAPs) greater than 10 tons per year for a single HAP or 25 tons per year for multiple HAPs also must obtain a Title V permit. The EPA has developed a list of 187 HAP that are either known or suspected to cause serious health effects. Facilities permitted under Title V have air pollution control requirements, must track and monitor emissions and controls, and keep records of the tracking.

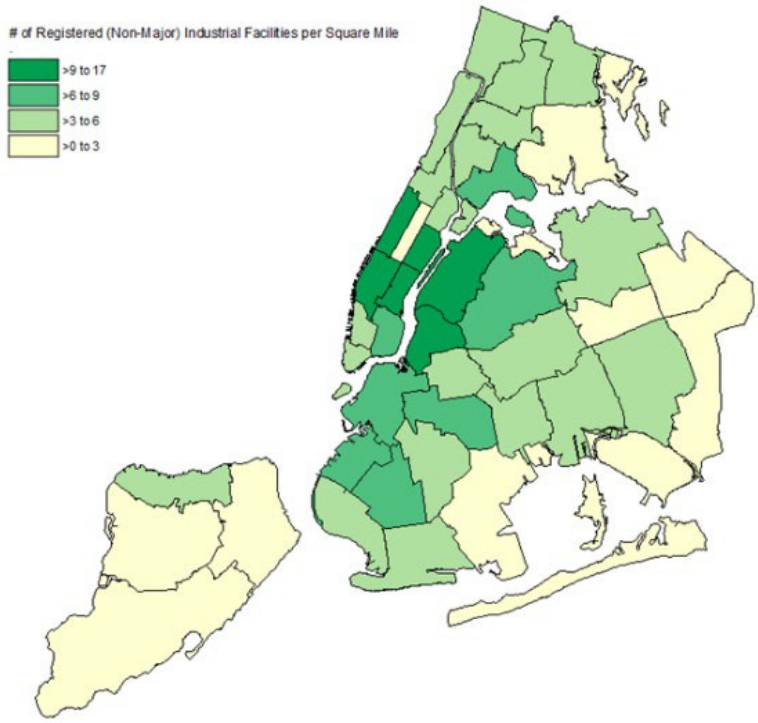
[67] US Environmental Protection Agency. Integrated Science Assessments. https://www.epa.gov/isa (2008)

As part of their responsibilities for protecting air quality in NYS, the DEC establishes annual guideline concentrations (AGC) and one-hour short-term guideline concentrations (1-Hour SGC) for non-criteria pollutants. AGC and SGC are used by DEC permitting and registration programs as a way to review emissions from facilities to protect the general public from adverse health effects from exposure to outdoor air contaminants. A listing of those pollutants and their guideline levels can be found on-line (https://www.dec.ny.gov/docs/air_pdf/dar1.pdf)

Owners of large facilities whose permits include conditions to limit emissions below major source levels, require a State Facility Permit. Information about the locations and types of facilities regulated under Title V or State Facility Permits can be accessed using the *DEC info Locator* mapping application (https://gisservices.dec.ny.gov/gis/dil).

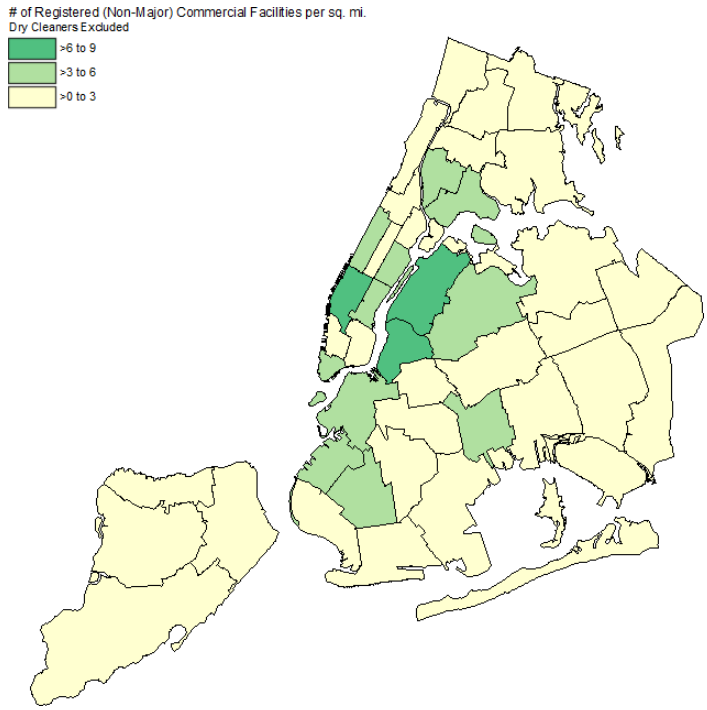
Air Facility Registrations are issued by DEC to non-major facilities whose emissions are less than half of a major source level. Database records of registered non-major facilities in NYC were reviewed with respect to business type and emissions, considering likely associations with asthma burden. Examples of facility types include but are not limited to dry cleaners, automotive shops, wood finishing facilities, refuse systems, apartment buildings, schools, and hospitals. These smaller facilities are more likely to be located near or within residential communities. A map of the density of currently registered non-major facilities by UHF-42 neighborhood can been seen in Figure 28 and for registered non-major facilities, excluding dry cleaners, in Figure 29. Dry cleaners were excluded because they account for a large proportion of registered non-major facilities, but dry-cleaning agents are not among the recognized asthmagens or asthma irritants. Maps for selected facility categories as representative of types of businesses that have potential emissions that could potentially be associated with respiratory effects can been seen in Appendix D (Figures D1- D5). In general, the UHF areas with the highest density of registered facilities (whether including or excluding dry cleaners) do not tend to be the same areas where asthma rates are highest.

Figure 28 - Number of currently registered non-major facilities per square mile, by UHF-42 neighborhoods in NYC



Data source: 2019 communication with NYS DEC Division of Air

Figure 29 - Number of registered non-major facilities per square mile excluding dry cleaners, by UHF-42 neighborhoods in NYC

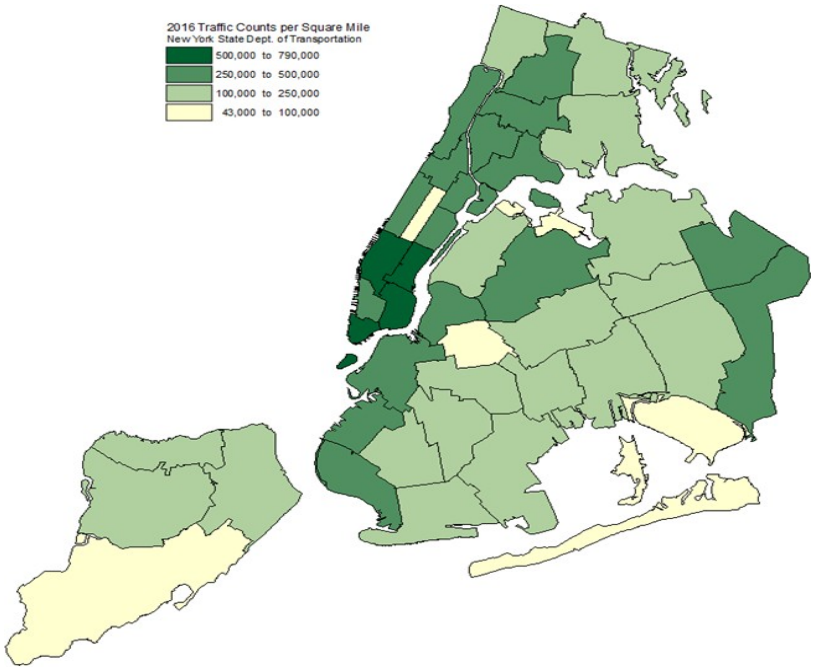


Data source: 2019 communication with NYS DEC Division of Air

Traffic

Traffic-related air pollution (TRAP) is a complex mixture of pollutants that contribute to ambient air pollution, particularly in urban environments like NYC where traffic density is high. Primary TRAP resulting from motor vehicle combustion include carbon dioxide, carbon monoxide, particulate matter, nitrogen oxides, sulfur dioxide, black carbon, hydrocarbon and HAP like benzene, ethylbenzene, toluene, and xylene. Secondary pollutants, ozone and secondary aerosols, form through chemical reactions in the atmosphere. Factors that influence TRAP include vehicle type, fuel type, age, and maintenance history. Quantifying TRAP can be challenging because it is difficult to measure all components of TRAP. Measured and modeled ambient fine particulate matter), nitrogen dioxide, and proximity to roadway have been used as indicators to estimate TRAP exposure.[68, 69] Many TRAP are also emitted by other sources. In NYC, fine particulate matter, nitrogen oxides and sulfur dioxide emissions from motor vehicles have been estimated to contribute to 17.5, 38.3 and 4.6% of local emission respectively, with trucks and buses having the greatest negative impact.[70] A map of traffic counts per square mile, by UHF-42 neighborhood in 2016, can been seen in Figure 30. Long term trends in average annual concentrations of these pollutants by borough can be seen in Appendix C, Figures C2-C6. Because of these challenges in assessing exposure to TRAP, it can be difficult to study health effects associated with TRAP. Despite that, exposure to TRAP, especially among those living within about 300-500m and downwind of more

Figure 30 – Traffic counts per square mile, by UHF-42 neighborhood, in New York City, 2016



Source: New York State Department of Transportation

[68] Alotaibi, R. *et al.* Traffic related air pollution and the burden of childhood asthma in the contiguous United States in 2000 and 2010. *Environment International* **127**, 858-867 (2019).

[69] Health Effects Institute (HEI). Traffic-related air pollution: a critical review of the literature on emission, exposure and health effects, special report 17. (HEI Panel on the Health Effects of Traffic-Related Air Pollution. Health Effects Institute Boston, MA, 2010).

[70] Kheirbek, I., Haney, J., Douglas, S., Ito, K. & Matte, T. The contribution of motor vehicle emissions to ambient fine particulate matter public health impacts in New York City: a health burden assessment. *Env Health* **15**, 89, (2016).

heavily trafficked roads[69, 71,] is associated with asthma development,[72,68,73,74] asthma exacerbation[72, 75, 76] and reduced lung function.[77, 78, 79,80, 81,82,83]

Meteorological Factors

Temperature and Precipitation

Altered weather patterns brought about by a changing climate can impact health outcomes like asthma.[84, 85] Warmer weather impacts the development of ground-level ozone which can irritate lung airways and tissues and cause or exacerbate asthma.[86] Increases in ED visits and hospitalizations among people with asthma, have been linked with spikes in ground-level ozone pollution.[84,85, 87] Hot and humid air can trigger or exacerbate asthma and may also indirectly impact asthma by influencing pollen production and season duration or by allowing allergens like mold and dust mites to thrive.

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[71] Zhu, Y., Hinds, W. C., Kim, S. & Sioutas, C. Concentration and size distribution of ultrafine particles near a major highway. Journal of the air & waste management association 52, 1032-1042 (2002)

[72] US Environmental Protection Agency. Integrated Science Assessments. https://www.epa.gov/isa (2008).

[73] Khreis, H. *et al.* Exposure to traffic-related air pollution and risk of development of childhood asthma: A systematic review and meta-analysis. *Environ Int* **100**, 1-31, (2017).

[74] Lovinsky-Desir, S. *et al.* Air pollution, urgent asthma medical visits and the modifying effect of neighborhood asthma prevalence. *Pediatric research* **85**, 36-42, (2019).

[75] Garcia, E. *et al.* Association of Changes in Air Quality With Incident Asthma in Children in California, 1993-2014. *Jama* **321**, 1906-1915, (2019).

[76] Shmool, J. L., Kinnee, E., Sheffield, P. E. & Clougherty, J. E. Spatio-temporal ozone variation in a case-crossover analysis of childhood asthma hospital visits in New York City. Environmental research 147, 108-114, (2016).

[77] Adam, M. *et al.* Adult lung function and long-term air pollution exposure. ESCAPE: a multicentre cohort study and meta-analysis. *The European respiratory journal* **45**, 38-50, (2015).

[78] Rice, M. B. *et al.* Long-term exposure to traffic emissions and fine particulate matter and lung function decline in the Framingham heart study. *American journal of respiratory and critical care medicine* **191**, 656-664, (2015).

[79] Bowatte, G. et al. Traffic-related air pollution exposure is associated with allergic sensitization, asthma, and poor lung function in middle age. Journal of Allergy and Clinical Immunology 139, 122-129.e121, doi: https://doi.org/10.1016/j.jaci.2016.05.008 (2017).

[80] Bowatte, G. et al. Traffic related air pollution and development and persistence of asthma and low lung function. Environment International 113, 170-176, doi: https://doi.org/10.1016/j.envint.2018.01.028 (2018).

[81] Lee, Y. J. & Rabinovitch, N. Relationship between traffic-related air pollution particle exposure and asthma exacerbations: Association or causation? Annals of Allergy, Asthma & Immunology 120, 458-460, doi: https://doi.org/10.1016/j.anai.2018.02.023 (2018).

[82] Ferguson, E. C., Maheswaran, R. & Daly, M. Road-traffic pollution and asthma - using modelledexposure assessment for routine public health surveillance. International journal of health geographics 3, 24-24, doi:10.1186/1476-072X-3-24 (2004).

[83] Mosnaim, G. et al. Geospatial Analysis for Assessing the Impact of High Traffic Volume on Asthma Exacerbations in a Mixed Rural-Urban US Community. Journal of Allergy and Clinical Immunology 143, AB210, doi: 10.1016/j.jaci.2018.12.640 (2019).

[84] D'Amato, G., Cecchi, L., D'Amato, M. & Annesi-Maesano, I. Climate change and respiratory diseases. European RespiratoryReview 23, 161-169, (2014).

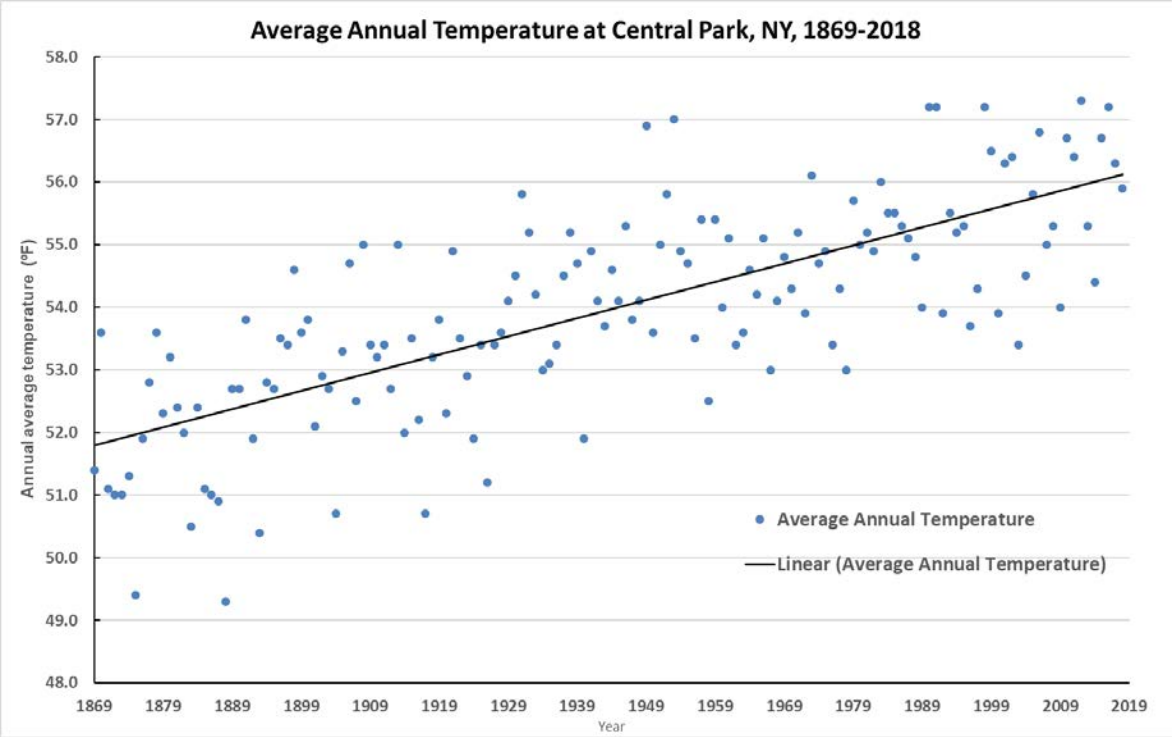
[85] D'Amato, G. et al. Climate change, air pollution and extreme events leading to increasing prevalence of allergic respiratory diseases. Multidisciplinary respiratory medicine 8, 12, (2013).

[86] United States Environmental Protection Agency (EPA). Ground-level Ozone Pollution: Health Effects of Ozone Pollution, https://www.epa.gov/ground-level-ozone-pollution/health-effects-ozone-pollution

[87] Sheffield, P. E., Knowlton, K., Carr, J. L. & Kinney, P. L. Modeling of Regional Climate Change Effects on Ground-Level Ozone and Childhood Asthma. *American Journal of Preventive Medicine* **41**, 251-257, (2011).

The graph in Figure 31 was created to display the temperature trends by National Oceanic and Atmospheric Administration (NOAA) at the Central Park, NY monitoring station from 1869 to 2018.[88] The average temperature during this period was 54ºF and each point represents the annual average temperatures for that year during this period. Over the past 150 years although there is a variation between years, the annual average temperature in Central Park shows an increasing trend. The graph in Figure 32 displays the annual precipitation data collected by the NOAA Central Park monitoring station from 1869 to 2018.[88] The lowest observed precipitation was in 1965 (26.1 inches) and the highest was observed in 1985 (80.6 inches). Annual precipitation data at this station also shows increasing trends of precipitation. Similar findings are observed across NYC and the rest of the state.

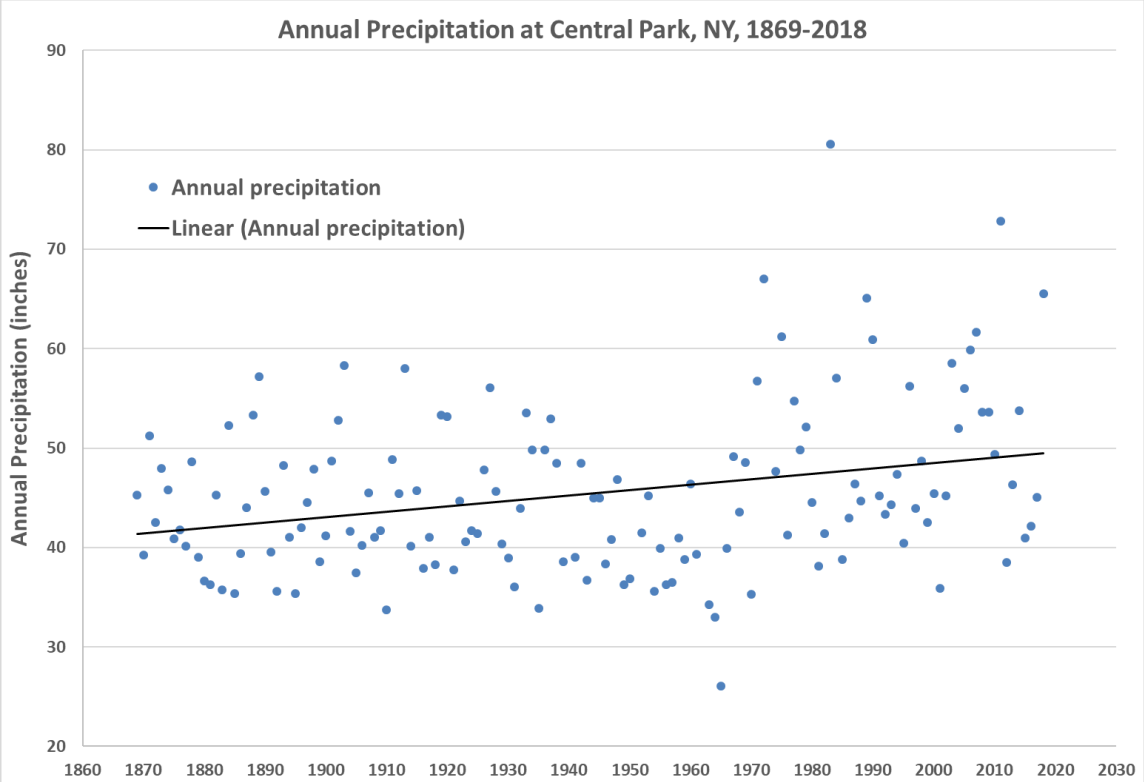
Figure 31. Average Annual Temperature at Central Park, NY, 1869-2018



Data Source: National Weather Service Historical Climatological Data, Central Park, NY

[88] National Oceanic and Atmospheric Administration. *Historical Climatological Data, Central Park by Year (1869-2018)*. https://www.weather.gov/okx/CentralParkHistorical (2019).

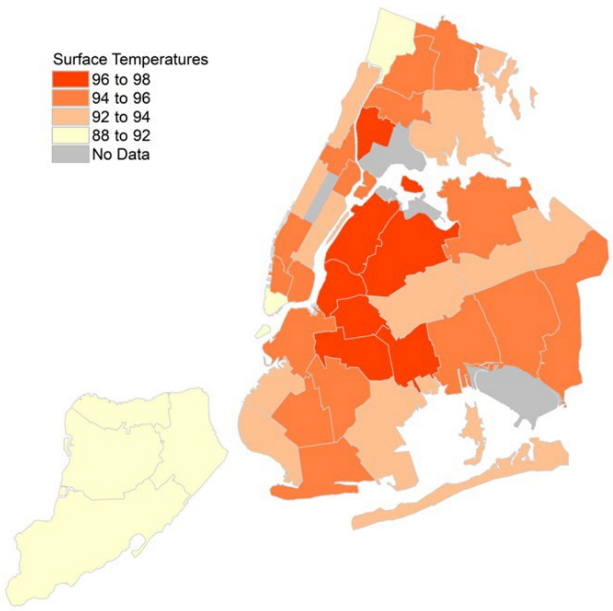
Figure 32. Annual Precipitation at Central Park, NY, 1869-2018



Data Source: National Weather Service Historical Climatological Data, Central Park, NY

As seen in the map of daytime summer surface temperature by UHF-42 neighborhood (Figure 33), there is variation in temperatures across neighborhoods within NYC. This variation may be due to local environmental factors, such as tree canopy or green space, and high building intensity that contribute to the urban heat island effect.

Figure 33. Daytime Summer surface temperatures by UHF-42 neighborhoods, 2009, NY



Data source: NYC DOHMH Environment& Health Data Portal. Daytime Summer Surface Temperature

Pollen

Pollen is one of the most common outdoor allergens in the US. Weather factors (including temperature and precipitation) and changes in land-cover and land development can lead to variation in pollen season duration and production from year to year. These factors can impact the start, end, and duration of crop and plant growing season and with warmer temperatures, pollen production for some species may begin earlier, or extend longer, resulting in an increase in the concentration, duration and intensity of air-borne pollen. Increased exposure to pollen and mold may trigger or exacerbate allergy and asthma symptoms as well as play a role in the development of asthma and allergy symptoms.[89, 90, 91]

The intensity of a person's allergic reaction to pollen depends on their sensitivity to pollen and the length of exposure, as well as amount of pollen emitted, and allergenicity of the pollen species.[90] The timing and duration of the pollen season varies geographically by pollen type (tree, weed, grass) and by species. Weed and grass pollen tend to have a longer season, ranging from mid-May to the end of September or early October, whereas the tree pollenseason is often shorter in NYS, usually occurring between the months of April and June.[92] According to the American Academy of Allergy, Asthma, and Immunology, weather variations andseasonal changes can play a role in production and movement of environmental pollen.[89] Hot, drywindy days aid in easy airborne movement of pollen, sometimes over long distances and leading to greater pollen distribution. Whereas during humid days, pollen gets damp and heavy with moisture, keepingit on the ground and reducing the likelihood of its distribution.

The National Allergy Bureau (NAB) currently has four pollen monitoring stations in NYS that track levels of pollen throughout the year, including one in NYC. Tree, weed, and grass pollen counts collected 2010-2018 at a monitoring station at Fordham College at Lincoln Center in Manhattan are summarized in Table 1. Variations in pollen season duration were observed across years and by pollen type (Appendix E, Figure E1-E2). In general, the season typically extends from early spring into fall. At 249 grains/m^3 the daily average tree pollen concentration during the monitoring period was above the value considered to be high (>=90 grains/ m^3) using the NAB classification, while the daily average grass and weed pollen concentrations were below the NAB value classified as high for grass (>=20 grains/ m^3) or weed (>=50 grains/ m^3) (Table 1). Pollen counts reflect land usage, and in NYC, the relative abundance of tree pollen at the counting stations compared to grass and weed pollen, may reflect landscaping practices.

[89] American Academy of Allergy Asthma & Immunology. Pollen Definition | AAAAI, www.aaaai.org/conditions-and-treatments/conditions-dictionary/pollen

[90] Schmidt, C. W. Pollen Overload: Seasonal Allergies in a Changing Climate. Envl Health Perspectives 124, (2016).

[91] D'Amato, G., Cecchi, L., D'Amato, M. & Annesi-Maesano, I. Climate change and respiratory diseases. *European Respiratory Review* **23**, 161-169, (2014).

[92] New York State Department of Health. New York State Asthma Surveillance Summary Report. 236-241 (Public Health Information Group, Center for Community Health, Albany, NY, 2013).

Table 1. Average Duration, Intensity and Months of Tree, Grass and Weed Pollen Season, Fordham College at Lincoln Center, 2010-2018

Pollen Type	Average Season Duration (Range)	Average Daily Concentration in Grains/m3 (Range)	Average Percent days with >= High Pollen Levels	Average Seasonal Months
Weed Pollen	123 (74, 177)	5 (0.6, 14)	1%	Late May-Early Oct
Grass Pollen	136 (106, 162)	3 (0.4, 11)	2%	Early May-Late Sep
Tree Pollen	63 (33,117)	249 (9, 1364)	24%	Late Mar-Early June

Increasing pollen counts have been associated with an increase in asthma ED visits, hospitalizations, and allergy medication sales.[93] Specific types of tree species in southern NYS and NYC have been associated with allergy medication sales, increased asthma symptoms, and respiratory related ED visits.[93, 94, 95, 96] A study estimating the projected impacts of climate change on oak pollen and subsequent allergenic asthma in the US found a substantial public health burden for the Northeast and in particular, for children under 18 years of age. [97] Additionally, studies in NYC have found that associations between certain tree pollen and asthma outcomes are of higher magnitude in children ages 6-18 years old. [93, 98]

Part II: Addressing the Burden of Asthma in NY

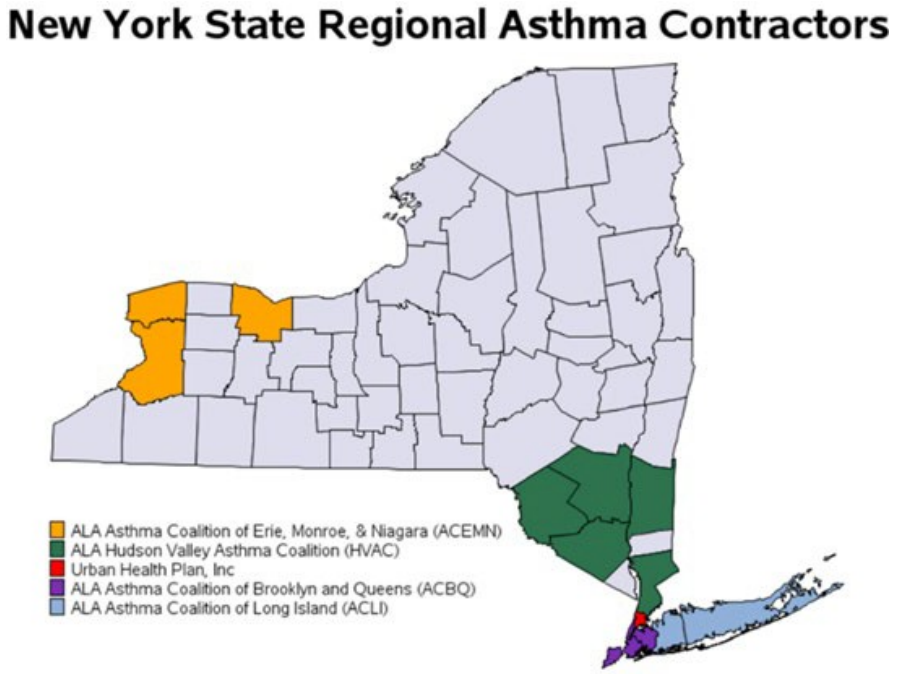
NYS Approach

The Department's NYS Asthma Control Program (NYSACP) has been working over the past two decades to build and maintain a program infrastructure positioned to lead statewide efforts related to asthma including: surveillance, evaluation, health communication, and coordination across strategic partners committed to expanding the quality and availability of comprehensive asthma control services. The NYSACP is primarily funded under a cooperative agreement competitively awarded through the Centers for Disease Control and Prevention's (CDC) National Asthma Control Program (NACP). The NACP currently funds 25 state, territorial, and municipal health departments to implement evidence-based strategies for controlling asthma using comprehensive, multi-component approaches.

[93] Ito, K. *et al*. The associations between daily spring pollen counts, over-the-counter allergymedicationsales, and asthma syndrome emergency department visits in New York City, 2002-2012. *Environ Health* **14**, 71-71, (2015).
[94] New York State Department of Health. New York State Asthma Surveillance Summary Report. 236-241 (Public Health Information Group, Center for Community Health, Albany, NY, 2013).
[95] Weinberger, K. R. et al. Levels and determinants of tree pollen in New York City. J Expo Sci Environ Epidemiol 28, 119-124, (2018).
[96] Lai, Y. & Kontokosta, C. E. The impact of urban street tree species on air quality and respiratory illness: A spatial analysis of large-scale, high-resolution urban data. Health & Place 56, 80-87, (2019).
[97] Ganesh, B., Scally, C. P., Skopec, Laura & Zhu, J. The Relationship between Housing and Asthma among School-Age Children. (Washington, DC: Urban Institute, 2017).
[98] Goodman, J. E., Loftus, C. T., Liu, X. & Zu, K. Impact of respiratory infections, outdoor pollen, and socioeconomic status on associations between air pollutants and pediatric asthma hospital admissions. *PloS one* **12**, e0180522, (2017).

CDC deliverables for NACP grantees are designed to address a set of evidence-based strategies outlined in the next section of this report. To guide this work, the NYSACP convenes strategic partners through the Asthma Partnership of NY (APNY). An advisory working group to the NYSACP, APNY engages leaders from NYS agencies, local health departments including the NYC DOHMH, health care systems, statewide associations addressing health and education, health plans (payers), and CBOs, to assist in statewide efforts to prioritize asthma and align cross-sector strategies to reduce the burden of asthma, particularly among populations disproportionately impacted. To support implementation of this work, the NYSACP awards State funds to regional asthma contractors working to address childhood asthma (Figure 34). NYS regional asthma contractors play a key role in coordinating efforts to integrate public health and health care systems interventions which support a reduction in the burden of asthma, as measured by decreased asthma-related avoidable hospitalizations and ED visits, improved quality of life, decreased mortality, and decreased health disparities. Since 2002, the efforts of NYS-funded regional asthma contractors have supported a 15 percent decrease in the asthma death rate, and a 20 percent decrease in asthma hospitalizations in NYS.

Figure 34.



Since 2008, available State funds allocated to childhood asthma programs and services have decreased by nearly 40%. The result has been a decline in regional asthma contractor coverage from statewide to just 15 counties currently served in Western NY, the Hudson Valley, Long Island, NYC, and the Bronx. One additional contract is funded to expand asthma management in schools and school-based health centers. Repeated reductions in state funding and the resultant condensed capacity of asthma contractors necessitates the allocation of limited resources to only a portion of NY's highest asthma burden areas. With federal funding from CDC remaining stagnant over ten years, NYSACP capacity to effectively implement CDC strategies and meaningfully serve NY's children and families burdened by asthma grows increasingly challenging. The Department can however prioritize asthma across existing key initiatives, including NY's Prevention Agenda and NYS Medicaid Redesign Team (MRT) waiver demonstration which are further described below.

Prevention Agenda 2019-2024: The Prevention Agenda 2019-2024 is NY's health improvement plan, the blueprint for state and local action to improve the health and well-being of all New Yorkers and to promote health equity in all populations who experience disparities. In partnership with more than 100 organizations across the state, the Prevention Agenda is updated by the New York State Public Health and Health Planning Council at the request of the Department. This is the third cycle for this statewide initiative that started in 2008. New to this 2019-2024 cycle is the incorporation of a Health Across All Policies approach, initiated in 2017, which calls on all State agencies to identify and strengthen the ways that their policies and programs can have a positive impact on health. Asthma is prioritized in two of the five Priority Areas including Prevent Chronic Disease and Promote a Healthy and Safe Environment. Evidence-based interventions within these priorities aim to contribute to: 1) decreased asthma emergency department (ED) visits and hospital admission rates for children; 2) increased access to ASME; 3) increased percentage of children and adults who were ever given an asthma action plan by a provider; 4) increased percentage of Medicaid enrollees with persistent asthma who are properly prescribed controller medication; and, 5) increased percentage of enrollees with persistent asthma that had a ratio of controller medications to total asthma medications of 0.50 or greater.

NYS 1115 MRT Waiver: Originally approved by the Centers for Medicare & Medicaid Services (CMS) in 1997, the Department's Section 1115 demonstration titled "Medicaid Redesign Team" (MRT), supports the implementation of a wide range of health care reform initiatives to improve access to health services and outcomes for low-income New Yorkers by:

- Improving access to health care for the Medicaid population
- Improving the quality of health services delivered
- Expanding coverage with resources generated through managed care efficiencies to additional low-income New Yorkers

Based on savings generated from NY's first MRT reforms, CMS approved an amendment in 2014 allowing NY to reinvest federal savings through a Delivery System Reform Incentive Payment (DSRIP) program. Implemented from 2015 to 2020, DSRIP worked to build infrastructure that supports providers' abilities to increase efficiencies in the delivery of care, engage in risk contracting, and support population health. Medicaid providers earned incentives for creating integrated, high-performing health care delivery systems (Performing Provider Systems) that improve quality of care, support population heath, and reduce costs. As a consistent driver of NYS Medicaid health care utilization, asthma was selected as a DSRIP project focus area to contribute to DSRIP's aim of reducing avoidable ED visits and hospitalizations by 25% over five years. DSRIP was instrumental in advancing asthma care through the implementation of large-scale asthma projects across NYS (see *NYS DSRIP Asthma Projects*).

In early 2020, former Governor Andrew Cuomo established the MRT II to identify cost-savings and continue Medicaid's transition to value-based payment (VBP). Asthma is prioritized in MRT II's goal of promoting effective and comprehensive prevention and management of chronic disease. DSRIP measure categories including potentially avoidable services and clinical improvement measures for asthma were mapped to DSRIP promising practices including

investment in CHWs for managing childhood asthma.[99] Integrating DSRIP promising practices and MRT II asthma-related priorities will be important to realizing asthma-related cost-savings and achieving measurement goals outlined in NY's Quality Strategy for the NYS Medicaid Managed Care Program which aims to ensure quality health care for over seven million Medicaid members.

National Frameworks and Strategies

Multiple national frameworks and resources provide guidance on implementing evidence-based and best practice strategies and interventions for addressing the burden of asthma. NYS applies the below frameworks and guidance to statewide and local efforts aimed at improving asthma care, asthma-related health outcomes, and quality of life for individuals impacted by asthma.

NAEPP Guidelines: The NAEPP was created in 1989 by the National Heart, Lung, and Blood Institute (NHLBI). The three main aims of NAEPP are to increase visibility of asthma as a major public health problem, establish evidence-based clinical practice guidelines and other supportive materials, and strengthen implementation of the guidelines via a variety of strategies. Since the *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma (EPR-3)* was released in 2007, substantial progress has been made in understanding asthma diagnosis, management, and treatment. Based on systematic reviews conducted by the Agency for Healthcare Research and Quality, and with input from NAEPP participant organizations, medical experts, and the public, the NHLBI supported the development of the *2020 Focused Updates to the Asthma Management Guidelines: A Report from the National Asthma Education and Prevention Program Coordinating Committee Expert Panel Working Group*. The 2020 Report focused on selected topics instead of fully revising the 2007 EPR-3. Updated topics include: Intermittent Inhaled Corticosteroids and Long-Acting Muscarinic Antagonists, Role of Immunotherapy in the Treatment of Asthma, Effectiveness of Indoor Allergen Reduction in the Management of Asthma, Effectiveness of Bronchial Thermoplasty, and Use of Fractional Exhaled Nitric Oxide (FeNo) in Asthma Management.

Global Initiative for Asthma (GINA) – Global Strategy for Asthma Management and Prevention: GINA was launched in 1993 in collaboration with the National Heart, Lung, and Blood Institute, National Institutes of Health, and the World Health Organization. GINA was established to increase awareness about asthma among health professionals, public health authorities and the community, and to improve prevention and management through a coordinated worldwide effort. GINA prepares scientific reports on asthma, encourages dissemination and implementation of the recommendations, and promotes international collaboration on asthma research. The GINA *Global Strategy for Asthma Management and Prevention* provides a comprehensive and integrated approach to asthma management that can be adapted to local conditions and for individual patients. It focuses not only on the existing strong evidence base, but also on clarity of language and on providing tools for feasible implementation in clinical

[99] DSRIP Promising Practices: Strategies for Meaningful Change for New York Medicaid. United Hospital Fund 2019. https://uhfnyc.org/media/filer_public/42/39/4239177f-a7a8-4444-885b-5116be998f33/dsrip_promisingpractices_20190716_web.pdf

practice. The GINA report is updated annually, with the 2020 report being the most recent update.

The Community Guide: The Guide to Community Preventive Services (Community Guide) is a compendium of evidence-based interventions selected by the Community Preventive Services Task Force (CPSTF). The Community Guide can be used by a variety of organizations in addressing public health issues in communities, including asthma control. The CPSTF is an independent, nonfederal team of public health and prevention professionals with expertise in a wide array of fields, including community preventive services, public health, health promotion, and disease prevention. The CPSTF systematically reviewed the evidence for effectiveness of home-based multi-trigger multi-component environmental interventions in improving asthma-related morbidity. The CPSTF published its recommendations and findings in the August 2011 Supplement of the American Journal of Preventive Medicine. Findings from this review indicated that home-based multi-trigger, multi-component, interventions with an environmental focus are effective in improving asthma symptoms, reducing the number of school days missed due to asthma, and improving the overall quality of life and productivity in children with asthma. The Community Guide also states that not only do these interventions lead to reduced asthma symptoms and improved quality of life, but providing such services also leads to substantial cost savings ranging from $5.30-$14 for every dollar invested. This national return on investment and economic evaluation evidence is a critical component in the justification for coverage of home-based asthma services.

The CPSTF also recommends school-based asthma self-management education interventions to reduce hospitalizations and ED visits among children and adolescents with asthma. Evidence shows interventions are effective when delivered by trained school staff, nurses, and health educators in elementary, middle, and high schools serving diverse populations. School-based self-management interventions for asthma control provide education or counseling to help children and adolescents with asthma learn to recognize and manage asthma symptoms, use medications and inhalers properly, and avoid asthma triggers.

CDC 6|18 Initiative: The CDC's 6|18 Initiative brings together public and private health care payers, purchasers, and providers to improve health and control health care costs by connecting prevention activities to health coverage and delivery with a focus on six high-burden, high-cost health conditions. The "18" refers to a set of evidence-based interventions that address the six conditions, of which asthma is one.[100] The 6|18 evidence-based interventions related to asthma include:

1. Promote evidence-based asthma medical management described in the NAEPP guidelines
2. Promote strategies that help people access and continue to use asthma medications and devices
3. Expand access to intensive self-management education for people whose asthma is not well controlled with guidelines-based medical management alone

[100] Implementing CDC's 6|18 Initiative: A Resource Center. https://www.618resources.chcs.org/what-is-the-cdcs-618-initiative/

4. Make it easier for people with asthma to have home visits by licensed professionals or qualified lay health workers if their asthma is not under control with medication and education. Home visits help people with asthma learn how to manage asthma and reduce triggers at home

NY's health care reform efforts align with these evidence-based interventions and support Medicaid's transition to a value-based health care delivery system.

CDC's CCARE Initiative and EXHALE Technical Package: The CDC National Asthma Control Program initiative, Controlling Childhood Asthma Reducing Emergencies (CCARE), aims to prevent half a million hospitalizations and ED visits among children with asthma by 2024. To help states achieve the goals of CCARE, the CDC created the EXHALE technical package which uses the highest level of evidence available to drive the improvement of asthma control to achieve a reduction in avoidable health care costs. EXHALE strategies highlighted are complimentary of one another and can improve asthma control and reduce health care costs.[101] Strategies include:

Education on asthma self-management
X-tinguishing smoking and secondhand smoke
Home visits for trigger reduction and asthma self-management education
Achievement of guidelines-based medical management
Linkages and coordination of care across settings
Environmental policies or best practices to reduce indoor, outdoor, and occupational asthma triggers

NYSACP efforts directly align with and fully integrate the EXHALE strategies. NY's initiatives are designed to integrate CDC's 6|18 evidence-based interventions and fully meet deliverables associated with CDC's NACP performance measures. The Community Guide, along with the NAEPP Guidelines and CDC recommendations, are used to guide efforts by the NYSACP and its partners to ensure that approaches are evidence-based, cost-effective, and culturally tailored to meet the needs of program participants.

Policies Supportive of Asthma Control

The Department works in collaboration with State and local agencies to actively promote and encourage adoption of the following asthma control polices. Those outlined in this report focus primarily on policies related to indoor and outdoor air quality and school-based policies supportive of asthma control. When implemented properly these policies and others can help to reduce asthma triggers and improve conditions where people with asthma live, learn, work, and play.

[101] EXHALE A Technical Package to Control Asthma. https://www.cdc.gov/asthma/pdfs/EXHALE_technical_package-508.pdf

Indoor and Outdoor Air Quality

Studies have shown that home ownership can play a role in asthma morbidities, with higher rates of asthma among renters.[102] Therefore, when interventions target the reduction of disparities of housing quality, consideration of the various aspects of the home environment should be made, especially those that cannot be controlled or addressed directly by residents. Rental housing inspections, federally mandated housing quality inspections of assisted housing, smoke-free housing policies, and integrated pest management may reduce renters' exposure to asthma triggers, particularly smoke, mold, pest allergens, and water leaks. Renters may have less control over correction of maintenance issues due to lease restrictions or issues being building wide. As a result, it is useful to consider additional actions which may be necessary when developing asthma control policies, including interventions by HUD, private landlord education, and legal aid for tenants. Upholding and enforcing building code requirements that address moisture control and proper ventilation, especially in multifamily buildings, can help control and improve indoor air quality. Policies addressing these issues are listed below and can support maintaining healthy indoor air quality conditions and assist in avoiding conditions that can foster pests and spread indoor pollutants throughout a building.

Smoke-Free Policies: Cigarette smoke and SHS are well known asthma triggers, and substantial evidence suggests that smoking affects asthma adversely. Smoke exposure in individuals with asthma is not only associated with more severe symptoms, but also with a poorer quality of life, reduced lung function, and increased utilization of health care including hospital admissions. Based on current knowledge, promotion and implementation of smoke-free policies are important to ensure individuals with asthma have access to a smoke-free environment.

> Smoke-Free Air Act: In 2002, NYC passed the Smoke-Free Air Act (in 2003, the State passed a similar law called the NYS Clean Indoor Air Act[103, 104]) which prohibits smoking in public places, including common areas of residential buildings with more than 10 units. The NYC DOHMH conducted the NYC Health and Nutrition Examination Survey (NYC HANES) after the two laws were implemented in 2004 and then again in 2013-2014 to measure the general health of adults living in NYC. During both surveys, biological samples were collected and analyzed for cotinine levels.[105] Results from 2013-2014 showed that 37% of adult non-smokers were exposed to SHS, decreasing from about 57% of non-smokers in 2004. But even with these substantial declines in SHS exposure, NYC has a higher proportion of non-smokers with elevated cotinine than the rest of the nation. Responses also showed a decrease in the proportion of smokers who smoked more than

[102] Hughes, H. K., Matsui, E. C., Tschudy, M. M., Pollack, C. E. & Keet, C. A. Pediatric Asthma Health Disparities: Race, Hardship, Housing, and Asthma in a National Survey. Academic Pediatrics 17, 127-134, (2017).
[103] Farley S, D. K., Hinterland K, Stalvey L,. Secondhand Smoke and Smoke-Free Housing in New York City. 1-4 (2018).
[104] Centers for Disease Control and Prevention Office on Smoking and Health (2018). *Smokefree Policies Reduce Secondhand Smoke Exposure*. https://www.cdc.gov/tobacco/data_statistics/fact_sheets/secondhand_smoke/protection/shs_exposure/index.htm
[105] Perlman, S. E. *et al.* Exposure to Secondhand Smoke Among Nonsmokers in New York City in the Context of Recent Tobacco Control Policies: Current Status, Changes Over the Past Decade, and National Comparisons. *Nicotine & tobacco research:* **18**, 2065-2074, (2016).

10 cigarettes a day from 48% in 2004 to about 29% in 2013-2014.[105] In addition, the NYC DOHMH worked with NYCHA, the Department and multiple partner organizations to encourage the adoption of smoke-free housing regulations among PHAs.[106]

Smoke-Free NYCHA: NYCHA's smoke-free initiative, Smoke-Free NYCHA, took effect in July 2018. The goal of this initiative is to reduce exposure to SHS, provide residents with a healthier home and work environment and provide support to those who smoke and would like to quit. Consistent with HUD regulation, the NYCHA initiative prohibits the smoking and the use of cigarettes, cigars, pipes, and hookah pipes in all indoor areas and within 25 feet of a NYCHA building. (https://www1.nyc.gov/site/nycha/residents/smoke-free.page)

Integrated Pest Management: Integrated Pest Management (IPM) is an effective and environmentally sensitive approach for managing, preventing, and suppressing pests with minimal impact on human health and the environment. IPM programs can differ and be tailored for specific situations, but largely consist of pest identification, monitoring, damage assessment, prevention, and use of a combination of biological, cultural, physical/mechanical, and chemical management tools. IPM is recommended by HUD, NYS and NYC authorities as an effective approach to controlling pests that can also reduce unwanted exposures to chemicals used in pesticides. Using an IPM plan can help address pest problems while minimizing impacts on health of residents and the environment.

NYS Law Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York Part 325 Application of Pesticides: Safe Use and Application of Pesticides: The types of pesticides that can be used are regulated by the EPA and for pesticides used in NYS, by the DEC. Some pesticides can be purchased and used by consumers in single family residences, however this NYS law requires that pesticide applications in multi-family and commercial buildings must be done by a licensed pesticide applicator.

NYC Local Law 55 of 2018: Passed in 2018, Local Law 55 requires landlords of buildings in NYC with three or more units, or any size building with a tenant with asthma, to take steps to keep their tenants' homes free of pests and mold. This includes safely fixing the conditions that cause these problems. Local Law 55 requires landlords to annually inspect building common areas for cockroach and rodent infestations, mold, and related conditions, use IPM practices, remove indoor mold, and fix standing water/leaks contributing to mold or moisture.

Outdoor Air Quality: Health Advisories are issued jointly by the Department and DEC when outdoor air quality is forecast to be a health concern for those with asthma, other respiratory problems, or heart problems. Following advice to modify outside activities to reduce exposures to ozone and particulate matter can protect lung function and prevent worsening of asthma

[106] Farley, S. M., Schroth, K. R. J., Curtis, C. J. & Angell, S. Evidence of Support for Smoke-Free Public Housing Among New York City Residents. *Public Health Rep* **131**, 2-3, (2016).

symptoms. The NYCCAS can be used to identify areas with higher pollution levels. The NYCCAS data can inform public and city officials about neighborhood air quality and local air pollution sources. Together with other information, the NYCCAS can help City agencies better understand the sources and health effects of air pollution and to plan measures to reduce it, for example, assessing whether traffic reduction measures result in improvements in outdoor air quality.

Asthma Control Policies for Schools

Asthma is the most common chronic illness among children making it critically important for schools to implement comprehensive asthma policies to support asthma management and a healthy environment. Adopting asthma-friendly policies and procedures will both help promote asthma control and guide a student's efforts to effectively manage their asthma both in and out of school. The *NYS Guide for Asthma Management in Schools* (the Guide), was jointly developed by the Department and the NYS Education Department (NYSED) to provide information and resources to assist schools with supporting students with asthma by establishing a comprehensive asthma management program. Designed for school and district employees, parents and guardians, members of local school boards, and stakeholder organizations, the Guide outlines strategies for helping students with asthma remain healthy, optimize learning, and participate fully in school. The Guide highlights several school related asthma control policies which can help schools and school districts control asthma triggers in the school environment. A sample of key policies are listed below and linked for additional information. The complete Guide can be accessed at www.health.ny.gov/publications/5163.pdf.

- Anti-idling Bus Policies: NYS Education Law §3637 requires school districts to minimize, to the extent practicable, the idling of the engine of any school bus, and other vehicles owned or leased by the school district while such bus or vehicle is parked or standing on school grounds, or in front of any school.

- Environmental Tobacco Smoke Policies: As discussed above, environmental tobacco smoke has adverse health effects on children, particularly young students and students diagnosed with asthma. Students with asthma who are exposed to environmental tobacco smoke through SHS, an asthma trigger, are at increased risk for asthma exacerbations. SHS is a risk factor for new cases of asthma among preschool-aged children. Below are several state and federal laws that prevent tobacco use in and on school grounds in NYS.
    - United States Code (U.S.C.), Chapter 70, §7183: Nonsmoking Policy for Children's Services, states that smoking shall not be permitted within and indoor facility owned, leased or contracted for and utilized for the provision of kindergarten, elementary, or secondary education or library services to children.
    - NYS Public Health Law, Article 13-E, §§1399-n, 1399-o and 1399-p: prohibits smoking and vaping in all indoor paces of employment which includes "school grounds" defined as "any building, structure, and surrounding outdoor grounds contained within a public or private preschool, nursery school, elementary or secondary schools, and any

vehicles used to transport students or school personnel. The law also requires "No Smoking"/ "No Vaping" signs to be displayed in smoking/vaping prohibited areas.
    - NYS Education Law Article 9 §409(2): Notwithstanding the provisions of any other law, rule or regulation, tobacco use shall not be permitted, and no person shall use tobacco on school grounds.

- Green Cleaning Product Policies: NYS Education Law §409-i: Procurement and Use of Environmentally-Sensitive Cleaning and Maintenance Products, requires that all public and nonpublic elementary and secondary schools procure and use environmentally sensitive cleaning and maintenance products in accordance with guidelines established by the Commissioners of the NYS DEC, NYSED and NYS Office of General Services. Environmentally sensitive cleaning and maintenance products are cleaning products having properties that minimize potential impacts to human health and the environment while maintaining effective maintenance for the protection of public health and safety.

- IPM Policies: Pests such as rodents and insects can create health problems for students with asthma because they have properties that can trigger an asthma exacerbation. Pests can also cause structural damage to schools and school grounds. As referenced above, IPM is a prevention-based pest management method that provides long-lasting pest control and is less harmful than traditional pest control. Unlike traditional pest control which relies on regularly scheduled pesticide applications, IPM targets the underlying causes of pest infestations strategies such as fixing leaks and managing garbage to deprive pests of food, water, and ways to get around. If pesticides must be used, IPM recommends the uses the least toxic chemicals, applied in the safest manner to protect people and pets. Adoption of IPM practices will help reduce students' exposure to both pests and pesticides.

    - Part 155 of the Regulations of the Commissioner of Education requires the provisions for a least toxic approach to IPM and establishing maintenance procedures and guidelines which will contribute to acceptable indoor air quality in NYS public schools (Title 8 of the New York Code of Rules and Regulations §155.4(d)(2)).
    - Pesticide Use and Notification: NYS Education Law (section 409-h): requires that at the beginning of each school year that schools provide, written notice to all parents, guardians, and staff that pesticide applications may take place at the school, instructions on registering with the school to get 48-hour advance notification of the pesticide applications, and the name of the school representative to contact for further information.

- Asthma Medication Access, Carry and Use Policies: Schools are required to ensure that students have access to medications in a timely manner as ordered by the

provider, and that appropriate licensed health professionals are available to administer the student's medications if a student is unable to self-administer consistent with state and federal laws.

- NYS Education Law, Article 19 §§916: Schools must permit a student diagnosed by a physician or other authorized health care provider with an asthmatic condition or another respiratory disease to carry and self-administer inhaled rescue medications for respiratory symptoms or to prevent the onset of exercise induced asthmatic symptoms during the school day on school property and at any school function with written permission of an authorized health care provider and written parental consent. The law also outlines criteria for allowing students to maintain an extra inhaler readily accessible at school.
- NYSED Memo – Policy for Stocking Albuterol Metered Dose Inhalers: The NYSED also permits schools to stock albuterol metered dose inhalers (MDIs) and/or liquid albuterol for use in a nebulizer for students diagnosed with asthma whose personal albuterol prescription is empty.

Asthma Initiatives in NYS

Multiple, ongoing efforts across NYS aim to expand evidence-based and best-practice interventions to reduce the burden of asthma and improve asthma-related health outcomes across clinical, home, school, and community settings. The below section provides individual summaries of interventions and initiatives currently underway in NYS which span the school, home, clinical, and community settings. While not an exhaustive list, the following descriptions highlight key efforts by the Department, NYC DOHMH, and strategic partners to improve the lives of New Yorkers living with asthma. These approaches and interventions are supportive of NY's health care reform efforts, align with national frameworks and evidence-based strategies described above, and drive NY's contribution to CDC's CCARE goals and 2019-2024 Prevention Agenda[107] priorities.

[107] Prevention Agenda 2019-2024: New York State's Health Improvement Plan. NYSDOH. https://www.health.ny.gov/prevention/prevention_agenda/2019-2024/

Project BREATHE NY

Overview

Project BREATHE NY, a joint initiative of the American Lung Association and NYSACP, embeds CDC's EXHALE strategies into a comprehensive framework designed to improve pediatric asthma-related health outcomes and reduce childhood ED visits and hospitalizations in NYS. By engaging health plans, health care provider systems, and community-based partners in sustainable processes for integrating guidelines-based asthma care coordinated across settings, *Project BREATHE NY* aims to achieve improvements in quality of life and health outcomes for children with asthma and their families. Based on NAEPP and GINA asthma guidelines, and in alignment with CDC 6l18 recommendations, *Project BREATHE NY* applies the Institute for Healthcare Improvement's (IHI) Model for Improvement to implement evidence-based care using EXHALE strategies. It also harnesses the learning and best practices identified during NYSACP led asthma quality improvement initiatives conducted in partnership with NYS regional asthma contractors over the past twenty years. *Project BREATHE NY* provides the structure, guidance, and tools for managed care organizations, health systems, and community-based partners to collaborate within a value-focused health care delivery system to effectively reduce the burden of asthma in NYS.

Description

The *Project BREATHE NY* Guide offers a roadmap for executing effective asthma quality improvement (QI) and includes a series of tools and educational resources which can be tailored to the unique needs of each partnership. The American Lung Association's NYS-funded regional asthma contractors provide leadership to build local *Project BREATHE NY* partnerships. This involves driving organizational engagement and coordination across partner settings, delivering technical assistance with planning steps, guiding QI focused activities, integrating tools and referral systems, and coordinating asthma guidelines training. Partnerships utilize a data measurement plan, a package of asthma QI measures, to collect data used to guide decisions and manage project challenges and successes.

Project BREATHE NY embeds EXHALE strategies by:

- Employing a sustainable multi-disciplinary team-based approach to asthma care delivery which uses a structured asthma workflow that empowers asthma care team members to provide quality care coordinated care across settings
- Expanding provider capacity through education and systems-level supports to deliver guidelines-based asthma care as the standard of care for all patients with asthma
- Ensuring asthma patients and their families/caregivers consistently receive comprehensive, individually tailored guidelines-based asthma care inclusive of asthma self-management education, medication adherence support, and follow-up
- Building effective bidirectional referral systems to coordinate delivery of multi-component home-based asthma services inclusive of assessment and reduction of environmental asthma triggers and asthma self-management education

- Establishing care linkages with schools and community-based service providers to support cross-sector coordination and address SDH

Results/Outcomes

Success of *Project BREATHE NY* strategies was demonstrated during asthma QI projects piloted by the Lung Association's NYS-funded regional asthma contractors across seven hospitals in NYC and Long Island beginning in 2012. These pilot projects resulted in training over 480 hospital staff on NAEPP Guidelines impacting asthma care delivered to over 3,400 children who were hospitalized or visited the ED due to asthma. Results included a statistically significant ($p<.01$) decrease in asthma-related hospital admissions among an analysis of 12-month pre- and post- electronic health record data for 568 children ages 2-18 hospitalized for asthma. Results also showed a 90% decrease in asthma-related hospitalizations among the subset of patients with 2 or more hospitalizations. Patient self-report data demonstrated similar successes including a significant decrease in both in-patient and ED events, and a significant decrease in prescribed oral steroids among patients engaged. Program successes resulted in one participating hospital's investment in a full-time nurse certified asthma educator (AE-C) dedicated to lead, coordinate, and monitor implementation and supported hospital efforts to achieve Magnet Designation and accreditation by the Joint Commission on Accreditation of Healthcare Organizations.

Implementation Considerations

- Demonstrated commitment and continuous engagement from leadership are critical to an organization's success in implementing and sustaining improvements through *Project BREATHE NY*. Strong leaders engaged at multiple organizational levels to identify key partners, gain buy- in across partners and departments, and maintaining organizational momentum are needed to provide a strong foundation for implementing this framework.
- Identification of dedicated project team leads including a physician champion and project coordinator, is essential. These roles are central to promoting the project, recruiting, and organizing multi-disciplinary team members, leading the implementation, ensuring reporting, and managing ongoing communication and sustainability of results.
- Building team capacity to deliver guidelines-based asthma care through ongoing provider training and education is necessary to ensure high quality care is the standard of care for all patients with asthma.
- Limited funding for NYS regional asthma contractors implementing this work restricts the roll-out, reach and potential impact of *Project BREATHE NY*. Additional resources are needed to spread *Project BREATHE NY* to all high asthma burden communities.

NYS Healthy Neighborhoods Program

Overview

The NYS Healthy Neighborhoods Program (HNP) seeks to reduce the burden of housing related illness and injury through a holistic, healthy homes approach. The program provides in-home assessments and interventions for asthma, tobacco cessation, indoor air quality, lead, fire safety, and other environmental health hazards in selected communities throughout NYS. The program targets housing in high-risk areas that are identified using housing, health, and socioeconomic indicators from census and surveillance data.

Description

The HNP uses a combination of door-to-door canvassing (roughly 67 percent of visits) and referrals (32 percent of visits) to reach residents in high-risk areas. Target areas include neighborhoods with a high number of families or individuals living in poverty and neighborhoods with a disproportionate number of residential health hazards. During a visit, the home is assessed for environmental health and safety issues. For problems or potential hazards identified during the visit, an outreach worker provides education (written and verbal), referrals and products to help residents correct or reduce housing hazards related to childhood lead poisoning, asthma, indoor air quality, and residential injury prevention.

The Department funds 15-20 HNP contracts awarded for a five-year period with annual budgets and workplans required. Only full-service county and city health departments with qualified environmental health staff are eligible to apply. HNP contractors are expected to partner with a local housing code enforcement agency in addition to at least three other community organizations.

Results/Outcomes

Factors used to evaluate the HNP program included assessment/reassessment asthma self-management knowledge (action plan, knowledge of triggers, early warning signs, how to avoid triggers), use of long-term asthma control medication, ED visits per resident, how many residents report their asthma is well controlled, number of referrals to a health care provider, and how often a HCP was accessed by a resident.

Previous studies have evaluated HNP interventions in NYS. Reddy et al. (2017) [108] concluded that low-intensity, home-based environmental interventions are effective as well as practical and feasible. Gomez et al. (2017) [109] concluded that low-intensity, home-based environmental interventions for people with asthma decrease the cost of health care utilization. Reddy et al. (2017) and Gomez et al. (2017) recommend that health insurers consider expanding coverage, especially among patients with poorly controlled asthma

[108] Reddy AL, Gomez M, Dixon SL. An Evaluation of a State-Funded Healthy Homes Intervention on Asthma Outcomes in Adults and Children. J Public Health Manag Pract. 2017 Mar/Apr;23(2):219-228.

[109] Gomez M, Reddy AL, Dixon SL, Wilson J, Jacobs DE. A Cost-Benefit Analysis of a State-Funded Healthy Homes Program for Residents With Asthma: Findings From the New York State Healthy Neighborhoods Program. J Public Health Manag Pract. 2017 Mar/Apr;23(2):229-238.

or those who may be at risk for poor asthma control, to include services that address triggers in the home environment as part of a comprehensive asthma care package.

Implementation Considerations

The NYS HNP's comprehensive approach to on-site housing assessments has proven to be cost effective and versatile. Many environmental housing concerns are interrelated. Low-cost education efforts and interventions can be tailored to the individual conditions identified during an assessment. For example, educational efforts, referrals, and interventions can be directed toward the adverse effects of environmental tobacco smoke on health impacts, indoor air quality, asthma exacerbation and fire safety with the dwelling occupants. HNP services are not available statewide due to limited resources and are limited geographically to high-risk areas. HNP design is reliant on the ability to make referrals to existing local services for more extensive interventions.

NYS Healthy Homes Pilot

Overview

The burden of asthma is disproportionately higher among individuals from low-income families. These individuals are more likely to live in older and poor housing stock with the presence of environmental triggers, such as moisture and air leaks, mold, ventilation issues, and pests. These housing quality issues and triggers impact daytime symptoms and increase the likelihood of being awakened at night due to asthma. Children whose asthma is not well-controlled are more likely to utilize costly services, such as unscheduled doctor's and urgent care visits, hospitalizations, and ED visits. The NYS Healthy Homes Pilot (the Pilot), a joint effort of the Department and the New York State Energy Research and Development Authority (NYSERDA), set to launch in 2021, aims to address these issues by utilizing a healthy homes approach to reducing adverse health outcomes related to asthma and resulting from unintentional household injury, while improving energy efficiency and building performance.

Description

The Pilot aims to improve overall health and quality of life for children with asthma, while also improving building performance and addressing social determinants of health (SDH) by incorporating home-based asthma-related services, energy efficiency and environmental trigger reduction services, and home injury prevention. The Pilot will target 500 homes in high asthma burden asthma regions primarily in NYC and Western NY. Children aged 0-17 and their families/caregivers will receive asthma self-management education (ASME), environmental home assessment, energy efficiency and environmental trigger reduction services, and home improvement work intended to prevent household injury.

Value-Based Payment (VBP) arrangements between managed care organizations (MCOs) and VBP providers will serve as a basis for the Pilot. MCOs will identify an attributable population of eligible patients seen by the VBP provider and conduct initial outreach to provide information about the Pilot and the services available. MCOs also commit to addressing sustainability of funding for Healthy Homes interventions beyond the conclusion of the Pilot.

Once eligible participants are informed of the Pilot by the health plan, community health workers (CHWs) will reach out to each participant's family/caregiver to formally engage them in the Pilot, obtain informed consent, and begin the process of collecting intake and SDH information. Then, CHWs, registered nurses (RNs) and NYSERDA participating home contractors will work together to provide the needed services noted below through a series of home visits, assessments, and remediation efforts, including quality control inspections. Pilot participants and their families will receive follow-up assessments via telephone at one-, six- and twelve-months post-completion of services. Due to the COVID-19 pandemic, some of these services may be provided virtually.

- Help from a CHW to guide and support the family through the program and with scheduling Pilot services and SDH-related referrals

- At least two home visits from an RN and/or CHW for in-home asthma education and medication support
- Home assessment for conditions that can cause asthma symptoms and safety issues that can be corrected to prevent home-related injury, such as fire safety and trip and fall hazards
- Resources that can make asthma symptoms better, like mattress and pillow covers, asthma-friendly cleaning kits, mold remediation, carpet removal, and vacuums with HEPA filters (a special filter that reduces dust, dander, and other common asthma triggers)
- Integrated pest management services and tips to keep the home pest-free
- Services to make the home more energy efficient, improve safety and comfort, and reduce energy bills, dependent on need and housing type, including but not limited to:
    - Air sealing treatment and installation of insulation to reduce drafts and keep the home warmer in the winter and cooler in the summer
    - Mold remediation and ventilation improvements to reduce moisture triggers that may exacerbate asthma symptoms
    - Improvements, repair, or replacement of heating systems to save on utility costs
    - Enhancement of home safety with new long-lasting smoke alarms and carbon monoxide detectors
    - Replacement of inefficient refrigerator/freezer to reduce energy use and save on utility costs
    - Replacement of existing light bulbs with energy-efficient LED bulbs to reduce energy use and save on utility costs
    - Installation of energy saving showerheads to save on utility costs

Results/Outcomes

Activities included in the Pilot have been shown to improve health outcomes for individuals with persistent asthma that is not well-controlled. Throughout Pilot implementation, health data will be collected on all home visits and follow-up calls using an electronic data collection system through an application-based program with all data stored securely on the Health Commerce System. Extensive evaluation will be conducted to document overall progress and to measure the effectiveness of the multiple integrated strategies included in the Pilot. The evaluation will examine improvements in asthma control and related health outcomes, reductions in in-home asthma triggers, improvements in energy efficiency, prevention of home-related injury, reductions in associated health and energy costs, and reductions in disparities among people with asthma in high burden regions of the state. The Pilot evaluation will help determine if coordinated services from existing programs and expanded interventions are sustainable through the VBP contract mechanism.

Implementation Considerations

The following factors continue to impact the Pilot's 2021 launch and subsequent implementation:

- **Buy-in from MCOs and VBP providers** will be essential to the sustainability of healthy homes interventions demonstrated by the Pilot. While Medicaid reimbursement for home

skilled nursing visits is allowable, VBP arrangements may need to prioritize expanding delivery and accessibility of these service for pediatric asthma patients. Covering additional CHW activities and home remediation work is expected to allow for more comprehensive services and better overall outcomes. Health plans and healthcare provider promotion and engagement of participants will also lend credence to these efforts and increase the availability of services.

- **Communication and collaboration between community-based organizations** will also be key to the success of the Pilot. CHWs, RNs and NYSERDA participating contractors will need to coordinate efforts and engage in open communication to ensure a seamless experience for participants and efficient delivery of services.
- **Coordination across sectors** is crucial for maximizing impact. The Pilot aims to build new and innovative partnerships between the energy and health sectors in NYS. Effectively engaging and building capacity for the workforce within each sector and laying the groundwork for sustainable collaboration across these partners will be key to demonstrating the full potential of a healthy homes approach integrating energy and health.

NYS DSRIP Asthma Projects

Overview

The NYS Delivery System Reform Incentive Payment (DSRIP) program was implemented April 2015-April 2020. This was a groundbreaking federal waiver demonstration program, approved by the Centers for Medicare & Medicaid Services (CMS), that allowed the State to reinvest federal savings generated by the first Medicaid Redesign Team (MRT) reforms. The DSRIP program was instrumental at promoting community-level collaborations and focused on system reform, specifically with a goal to achieve a 25 percent reduction in avoidable hospital use over five years. Safety net providers collaborated to implement innovative projects focusing on system transformation, clinical improvement, and population health improvement, with all DSRIP funding being awarded based on performance linked to achievement of project milestones and targets on performance metrics.

Description

To improve the health of New Yorkers, the DSRIP program included strategies to ensure access to clinically effective and efficiently delivered services and to reduce disparities in health outcomes. The clinical quality domain of the program encompassed various chronic disease focus areas, including asthma management. Improvement in clinical processes and quality for asthma management was addressed by 13 Performing Provider Systems (PPS) that selected the DSRIP asthma projects:

- Project 3.d.ii Expansion of asthma home-based self-management program: To ensure implementation of asthma self-management skills including home environmental trigger reduction, self-monitoring, medication use and medical follow-up to reduce avoidable ED and hospital care. Special focus will be on children where asthma is a major driver of avoidable hospital use.
- Project 3.d.iii Implementation of evidence-based medicine guidelines for asthma management: To ensure access for all patients with asthma to care consistent with evidence-based medicine guidelines for asthma management.

Results/Outcomes

Over the five years of implementation, improvement was demonstrated in the asthma performance measures among the 13 PPS implementing these asthma projects:

- The asthma medication ratio improved from 60.5% in baseline measurement year to 69.6% in final measurement year.[110]
- Asthma medication management, defined as filling medications for at least 75% of days covered, improved from 32.1% in the baseline measurement year to 36.8% in the final measurement year.[110]

[110] Independent Evaluator for the New York State Delivery System Reform Incentive Program, Draft Summative Report, March 2021

Implementation Considerations

While these indicators represent significant progress and impact, continued opportunities for improvement in asthma population health outcomes can be identified and addressed through ongoing and future State efforts. Continued engagement of and investment in community-based organizations and community health workers to conduct asthma home visits and home-based interventions can assist with targeting services and reducing disparities in health outcomes. Based on the DSRIP program successes, promising practices and lessons learned can be identified and sustained to maintain and spread the demonstrated improvements.

NYS Children's Environmental Health Centers

Overview

The NYS Children's Environmental Health Centers (CEHC) [111] are part of a statewide network of specialty units that provide consultation/guidance, education/training, public health marketing, and clinical/evaluation services to improve the recognition, evaluation, management and prevention of environmental health problems in children. Physicians and other healthcare providers at the Centers are experts in the field of children's environmental health. This Network is a resource for all children, parents, health care providers, daycares, schools, and communities in NYS.

Description

This program is comprised of a network of CEHC designed to reach all of NYS, with some special emphasis on under-served populations. Network Centers are located in Long Island, NYC, Westchester, Albany, Syracuse, Rochester, and Buffalo. Centers are led by pediatricians trained in environmental health and are supported by a grant from the Department. Many Centers have leveraged additional funding through other grants and partnerships to improve their reach and impact.

A key component of the Centers' activities is the provision of environmental health education. Education is targeted to individual patients and their parents/guardians, as well as to groups such as healthcare providers, schools, daycares, and community organizations. Education and training for health professionals working outside the Centers is especially important in order to broaden the base of environmental health knowledge within the medical community and to increase awareness of potential environmental health hazards. The Centers are also active in promoting policies that protect and improve children's health. This includes creating strong community partnerships with a variety of stakeholders. Messages are targeted locally and statewide, as appropriate.

Centers also conduct clinical and evaluation services. Some Centers have strong clinical practices with a particular focus on pediatric asthma and allergies. For example, the Children's Environmental Center of the Hudson Valley is led by a well-respected group of pediatric pulmonologists, while the NYC Children's Environmental Health Center at Mount Sinai has an active Pediatric Allergy Clinic and Pediatric Pulmonology Clinic with robust environmental asthma programs. These two Centers place particular focus on treating patients with asthma as well training many healthcare providers on identifying, preventing, and managing pediatric asthma. They act as preceptors, conduct Grand Rounds, and hold other seminars/webinars, among other asthma education activities. They also partner with the American Lung Association (ALA) to train visiting nurses for improved home health care, have developed a wide variety of informational tools for the public, and have a strong social media presence for distributing public health marketing materials, including a large number specific to asthma.

[111] NYS Children's Environmental Health Centers. https://nyscheck.org/about/

Results/Outcomes

The Centers routinely track the following metrics: number of clinical environmental health consultations conducted; number of families screened for environmental health concerns; healthcare providers educated; trainees in internships; number of community engagement meetings or events; number of scholarly products produced; and various social media metrics. In their first year alone, the CEHC Network provided education to 4,750 health care professionals and trained 100 healthcare trainees on how to incorporate environmental health into routine well childcare. Furthermore, they educated 15,444 individuals on environmental health concerns and served 2,752 families through clinical environmental health consultations and screenings. These numbers have significantly increased over the two subsequent years of the Network as Centers became more established. Updated statistics are being compiled for a three-year report. In the most recent quarter, the centers had 19,200 twitter impressions and 5,200 views on their website. The Centers have also produced a large number of environmental health resources in print and video formats.

Implementation Considerations

A key factor for success of the CEHC Network is strong centralized management and leadership provided by Mt. Sinai School of Medicine which keeps the Network connected and focused. A key consideration is continued adequate funding to sustain these programs to meet the needs of NYS. Additionally, the large population and varying geographic regions of NY make it difficult to address varying needs.

Cooling Centers

Overview

People with chronic health conditions like asthma are vulnerable to the impacts of extreme heat. Sudden changes in weather and hot and humid weather conditions often trigger asthma but being in an air-conditioned environment can help prevent heat related illness and avoid exacerbation of asthma. New York State Department of Health (NYSDOH) and New York City (NYC) Office of Emergency Management (OEM) work with multiple local agencies and facilities to identify cooling centers (publicly accessible, cool-down facilities and sites) across NYS and disseminate the information through various platforms to improve awareness of their locations.

Description

Spending a few hours in an air-conditioned environment can reduce the impacts of heat on health. To provide communities with a place to cool down during hot summer days, local agencies in NYS set up cooling centers, which are usually publicly available air-conditioned or cool recreation spaces.[112] Cooling centers often include libraries, senior and community centers, malls and grocery stores. In the absence of air-conditioned spaces, recreational areas with shade structures or trees, spray parks and community pools, may be included as part of a plan for helping the public cool down during hot weather.

NYSDOH works with county health departments and county emergency management and preparedness offices while NYC OEM works with facility managers every year to identify cooling centers within each county.[113] In NYS, several agencies including local health departments, county emergency management offices, local municipality offices, fire departments, library systems, and non-profit organizations like the American Red Cross are involved in setting up cooling centers as a heat-adaptation resource for their residents.[115]

Results/Outcomes

In a survey conducted in 2013, 16 of 57 NYS counties (excluding NYC) had cooling centers. Counties without cooling centers cited numerous reasons for not considering cooling centers as a heat-adaptation resource in their jurisdiction. [114] The cooling center program developed an interactive map and maintains a list of cooling centers[115] to improve public awareness of cooling center locations and operating hours during the summer. The program also conducts outreach among county agencies and the general public to increase awareness of the impacts of heat on health and ways to reduce this impact. Since the program began, the NYSDOH has seen a significant increase in participation, from 16 counties reporting cooling centers in 2013 to 42 counties reporting locations in 2019. Experiences with successes, limitations and challenges have

[112] Nayak, S. G., et al. Accessibility of cooling centers to heat-vulnerable populations in New York State. *Journal of Transport & Health* 14 (2019): 100563. https://www.sciencedirect.com/science/article/pii/S2214140519300787

[113] NYC Cooling Center Finder: https://maps.nyc.gov/cooling-center/inactive.html?1612205400000

[114] Nayak SG, et al. Surveying Local Health Departments and County Emergency Management Offices on Cooling Centers as a Heat Adaptation Resource in New York State. J Community Health. 2017 Feb;42(1):43-50. doi: 10.1007/s10900-016-0224-4. PMID: 27516066.

[115] Cooling Centers. NYS Department of Health. https://www.health.ny.gov/environmental/weather/cooling/

been summarized in CDC's guidance document for cooling center implementation[116] and heat response guidance.[117]

Implementation Considerations

Cooling centers are a cost-effective intervention when existing facilities in the community can be used during extreme heat conditions for this purpose. Challenges that have been most commonly identified are the unavailability of air-conditioned facilities of adequate capacity in the community and the inaccessibility of cooling centers via public transportation. Other challenges include restricted access to the general public (example senior centers) and limited operating hours (facility closed in the evening when temperatures are peaking). County agencies are encouraged to work with the facilities to extend availability and improve accessibility.

Cooling centers are typically implemented as part of a larger heat response plan which can consist of a variety of activities such as health hot lines, a warning communication system (alerts and advisories), and improving access to cooling assistance. The NYSDOH and NYC DOHMH work with their regional National Weather services offices to issue heat advisories and alerts with additional information on vulnerability[118] and cooling center locations. Both departments also work with the Office of Temporary Disability Assistance [119] to increase awareness of their HEAP Cooling assistance program that helps eligible New Yorkers obtain an A/C unit or fan for their home.

Key factors for successful utilization of cooling centers would include improving public awareness of heat impact on health, working with local NWS offices to plan cooling center availability, identifying ideal cooling center locations that are accessible to heat-vulnerable populations, and using multiple platforms to disseminate information in a timely manner.

[116] The Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation. CDC. https://www.cdc.gov/climateandhealth/docs/UseOfCoolingCenters.pdf

[117] Heat Response Plans: Summary of Evidence and Strategies for Collaboration and Implementation. CDC. https://www.cdc.gov/climateandhealth/docs/HeatResponsePlans_508.pdf

[118] Heat Vulnerability Index: NYSDOH: https://www.health.ny.gov/environmental/weather/vulnerability_index/index.htm

[119] Home Energy Assistance Program (HEAP). Cooling Assistance Benefit. Office of Temporary and Disability Assistance (OTDA). https://otda.ny.gov/programs/heap/#cooling-assistance

NYS Asthma Management in Schools

Overview

Asthma is a leading cause of school absenteeism. Providing school-based asthma self-management education (ASME) services to children has been shown to reduce asthma symptoms, improve asthma management, and decrease asthma-related ED visits and hospitalizations. School-based ASME provides education to help students with asthma and their caregivers recognize and manage asthma symptoms, use medications and inhalers properly, and respond to asthma-related problems. The value of school-based ASME in improving health outcomes and quality of life for children with asthma has been demonstrated to be effective and is recognized and promoted by the CDC, the NAEPP, the EPA, The Community Guide, and national associations including the American Lung Association.

Description

The Department supports a contract with the American Lung Association to implement the NYS Asthma Management in Schools Initiative to expand school-based asthma services. Guidance, training, and technical assistance are provided to facilitate school, school district, and school-based health center efforts to establish and/or expand comprehensive asthma management programs, including provision of ASME. The Lung Association supports dissemination and use of the *NYS Guide for Asthma Management in Schools* (the Guide) which provides information and resources to schools on adopting asthma-friendly policies, reducing common asthma triggers in the school environment, caring for students with asthma, implementing ASME programs, and assisting school personnel to help students with asthma remain healthy and participate fully in school.

A central component of the NYS Asthma Management in Schools Initiative is the provision of ASME using the Lung Association's *Open Airways For Schools®* (OAS) and *Kickin' Asthma* programs which are used nationally with demonstrated success. Since its introduction more than a decade ago, OAS has reached hundreds of thousands of children with asthma in more than 40,000 elementary schools across the country. The program, which is delivered over 6 sessions, teaches children ages 8 to 11 with asthma how to detect the warning signs of asthma, avoid their triggers and make decisions about their health. [120] *Kickin' Asthma*, the ASME program for older students ages 11-16 includes different age-appropriate learning techniques and highlights self-management practices, such as recognizing triggers and proper medication use.

Results/Outcomes

The OAS and Kickin' Asthma programs have been evaluated and proven effective. Evaluation studies show that children who participate in OAS have fewer and less severe asthma exacerbations, have improved academic performance, have more confidence to manage their asthma, and are able to exert greater influence on their parents' asthma management decisions. *Kickin' Asthma* has also been proven effective in improving asthma self-management skills and

[120] https://www.lung.org/lung-health-and-diseases/lung-disease-lookup/asthma/asthma-education-advocacy/open-airways-for-schools/why-use-open-airways.html

decreases emergency room visits. In NYS, OAS has an ROI of $11.22 per $1 for students with asthma who had 1 or more hospitalizations due to asthma. These students also saw a decrease in ED visits by 59% and additional hospital stays by 58%.[121]

Implementation Considerations

Key factors influencing the success of school based ASME programs include:

- Identification of sustainable funding for program implementation.
- Partnering with non-traditional facilitators to implement the program.
    - For example, in NYS, the Lung Association has formed partnerships with college nursing programs to train nursing students deliver the school based ASME programs as one of their required clinical placements.
- Schools may not have a school nurse on site every day and may find it difficult to find time to deliver program.
- As students age new challenges may arise.
    - Students may need to retake this course to reinforce OAS content or complete a different course such as *Kickin' Asthma* which is tailored for students ages 11-16.

[121] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5117439/

The NYS School Environmental Health Program

Overview

The NYS School Environmental Health Program (SEHP) is a statewide school environmental health program that provides best practices, tools, knowledge, and resources to parents, students, teachers, school administrators, and other school personnel. The program was developed to help NYS schools improve the health and safety of their school environment. The program has nine environmental health focus areas, many of which have a direct connection to asthma triggers, and shares program materials which introduce ways to help reduce these triggers.

Description

This intervention is aimed at all K-12 schools in NYS, including public, private, charter, and tribal schools. Briefly, the program requires creating a Green Team, completing a school environmental health self-assessment form, and developing goals and objectives related to findings from the self-assessment. The program also asks participating schools to demonstrate success in the following nine areas: Indoor Air Quality (IAQ); Energy and Resource Conservation; IPM; Mold/Moisture; Chemical and Environmental Hazards; Cleaning and Maintenance; Transportation; Construction/Renovation; and Water Quality. Requirements for demonstrating success include such actions as completing checklists, producing, or creating documents such as school procedures or protocols, writing short descriptions (400 words or less) of actions taken, and completing recommended free online training webinars. To cap off their SEHP experience, schools are asked to tell their story in a brief write-up, hold a poster day at their school to celebrate school environmental health, and submit a plan to sustain their success. The Department has partnered with over 40 NYS agencies and non-governmental organizations, as well as the EPA and national organizations to create this program and currently receives a small 2-year grant from the EPA. Partners include the NYS Asthma Program, the NYS DEC, the NYS Department of Labor, the NYSED, the NYS Children's Environmental Health Centers Network, the NYS Asthma Management in Schools Initiative, and many others listed as Steering Committee members on the SEHP page on the Department's website.

Results/Outcomes

The program, after completing pilot testing, has been launched statewide. A comprehensive list of SEHP program resources for schools is located on the Department's website. The program will be evaluated on several metrics including: the number of schools that enroll; the number of schools that complete each level or Focus Area of the program; the number of times online trainings are accessed; the number of website hits; the number of inquiries to the project team; the number of and attendance at regional seminars; and the number of teachers that receive Continuing Education credits from our offerings.

Implementation Considerations

An identified limitation that must be fully examined and addressed is the challenge of gaining administrative support for school environmental health activities such as this program. A plan to target audiences in decision making roles, including superintendents, principals, and facilities managers, that is focused on their barriers and needs, is under development. Other identified

limitations are the voluntary nature of the program and competing interests for resources such as staff time and money. To address the latter, the program was designed to be very low cost, including free resources. Program requirements are also designed to be easy to complete, yet effective. In fact, some components are already required by regulation, so should already be completed. In addition, suggested trainings are short in duration and requested descriptions of actions are one page or less. Success of the program will largely depend on schools and/or districts having an environmental health champion to shepherd this program and fully utilize its resources. Lastly, the need for an enhanced communication system among schools and experts on school environmental health was identified in our pilot testing. Development of critical infrastructure for a communication network and plan is needed, so that schools stay informed and can learn from experts and each other in a community of practice.

Asthma Medication Administration in NYC Public Schools

Overview

To help school children achieve asthma control and avoid exacerbations, the Office of School Health (OSH), a joint program of the NYC DOHMH and the NYC Department of Education that provides care to approximately 1.3 million NYC students each year in approximately 1,300 schools Citywide, works with students, families and a child's primary care provider (PCP) to plan in-school services at no cost to families. After discussion with and consent from the family and primary care provider, OSH administers students' rescue and controller medications during the school day, provides enhanced asthma education, manages in-school asthma exacerbations, and conducts frequent asthma control assessments. OSH also collaborates with community PCPs about the care of their patients. If a student does not have a primary care provider, OSH physicians are able to prescribe albuterol and Flovent as needed for in-school use.

Description

The OSH is required to have a school nurse in all NYC public elementary schools with more than 200 students or a documented clinical nursing need. Within these schools, OSH nurses offer in-school administration of asthma controller medication and/or quick relief medication to students with poorly controlled asthma whose parent/guardian and PCP agree and complete the Medication Administration Form (MAF). An MAF is required for children to receive medication in school. A new form, signed by a physician, is required at the beginning of every school year.

Children with asthma who have not submitted an MAF will be evaluated by an OSH physician if they appear to have poor asthma control. If the evaluation establishes that the student has poorly controlled asthma or is at risk for poor asthma outcomes, the OSH physician, after discussion with the student's PCP and with the parent's or guardian's consent and completion of a MAF, will authorize administration of fluticasone 110 mcg daily to the student on school days. Without an MAF on file, the school nurse cannot give the child rescue medication during an exacerbation. Emergency medical services will be called instead.

This program addresses reasons for low medication adherence, including medicine not being taken or taken incorrectly, and provides an opportunity for school nurses to counsel students on the importance of adherence and to monitor high risk students. This strategy has been shown to be very effective for managing patients with poorly controlled asthma and medication adherence issues.[122]

This program is funded by City Tax Levy dollars and includes approximately $750,000 for asthma medication.

Results/Outcomes

[122] Halterman JS, Szilagyi PG, Yoos HL, et al. Benefits of a school-based asthma treatment program in the absence of secondhand smoke exposure: results of a randomized clinical trial. *Arch Pediatr Adolesc Med*. 2004;158(5):460-467.

At the end of the 2018-2019 school year, more than 61,000 (9.7%) NYC public school students in grades K-8 had active asthma, and among these, 47.7% (n=29,184) had an MAF on file. Fewer K-8 students with asthma living in Bronx (40.4%) had a completed MAF compared to students living in all other boroughs (Brooklyn = 46.1%, Manhattan = 46.7%, Queens = 54.8, Staten Island = 57.6%).

Implementation Considerations

Barriers include a need for more information at various stages of implementation:

- More education needed for parents about asthma as a chronic illness, including that many students will need long term controller medication even when they appear well. Presentations to parents about asthma treatment would increase knowledge.
- More outreach needed to community providers about OSH asthma programming. Provider detailing about these programs would increase awareness.

Asthma Case Management Program in NYC Community Schools

Overview

The Office of School Health (OSH), a joint program of the NYC DOHMH and the NYC Department of Education that provides care to approximately 1.3 million NYC students each year in approximately 1,300 schools citywide, offers the Asthma Case Management Program (ACMP) in 25 Community Schools, neighborhood hubs where students receive high-quality academic instruction, families can access social services, and communities congregate to share resources and address their common challenges. The program provides case management services to students with poorly controlled asthma that are at risk for adverse outcomes in select Community Schools serving grades K-8.

Description

The overall goal of the ACMP is to support students with asthma and their families through improved collaboration with community providers for medication administration in school, enhanced asthma management education, and referrals to appropriate asthma resources. Specific objectives of the program are to increase the number of children with poorly controlled asthma in Community Schools that have an Asthma Medication Administration Form (MAF) on file; increase the percentage of children on controller medications; and increase the percentage that are administered controller medications at school. An MAF is completed by parents/guardians and is required for students to receive medication in school. Health educators and social workers collaborate with school health nurses and physicians to coordinate and deliver these services. NYC Community Schools were chosen as the delivery site for the ACMP given their holistic and comprehensive approach to education, that prioritizes student wellness, readiness to learn, personalized instruction, community partnerships and family engagement as key strategies to leverage better academic outcomes among high-need students.

This program is funded by City Tax Levy dollars.

Results/Outcomes

During the 2018-2019 School Year, the program provided 2,670 asthma management related services, the breakdown is as follows: 900 Student Asthma Questionnaires (SAQ) completed, 800 MAF obtained, 470 phone outreaches conducted to primary care providers within the designated communities to educate on OSH programs, 400 students received Open Airways for Schools®, over 100 parent/teacher asthma workshops conducted, and 85 Healthy Homes referrals generated.

The increase in the number of MAFs and SAQs submitted among students in the program has proven to provide greater asthma control among students enrolled in ACMP compared to students not enrolled in ACMP.

Implementation Considerations

Implementation barriers include a need for more parental education about asthma as a chronic illness, including that many students will need long term controller medication even when they appear well.

As supported by the literature, psycho-social issues such as exposure to environmental triggers in the home, financial constraints, or attitudes toward disease are also barriers to asthma care among the population served.

Harlem Health Advocacy Partners

Overview

Despite a rich and vibrant history, East and Central Harlem have been subject to racist policies and processes such as redlining and "benign neglect" that have contributed to disinvestment, and, relative to other NYC neighborhoods, high rates of poverty and poor health outcomes among residents for many decades.[123, 124] Harlem Health Advocacy Partners (HHAP), a program of the NYC DOHMH Center for Health Equity and Community Wellness, aims to close racial/ethnic gaps in health and well-being faced by adult public housing residents in East/Central Harlem in comparison to other New Yorkers. The program deploys community health workers (CHW) to support residents in several ways, including improving management of chronic health conditions such as asthma. CHWs have been part of several effective programs implementing EXHALE strategies.[125] The EXHALE strategies include education on self-management of asthma, guidelines based medical management, extinguishing smoke exposure and other indoor and outdoor asthma triggers, home visits and linkages to care across settings.

Description

HHAP offers its services to adult residents (aged 18+) in five NYCHA developments in East and Central Harlem, with an estimated population of 10,000 adults.[124] Participation in HHAP is tailored to personal preference or need and may include health coaching for approximately 6 months, participation in group wellness activities held at developments (walking groups, peer groups and workshops on various health/well-being topics), referrals to health navigation or other services, and engaging in advocacy projects with community health organizers. Participants are engaged through outreach, primarily at the housing developments, and through partner and peer referrals.

The CHW assesses health coaching participants at intake and approximately 6 months later as they wrap up their coaching. Assessments cover health and social topics useful in developing a health coaching action plan. Topics include health conditions, access to care, management and control of chronic conditions, medication adherence, health behaviors (smoking, diet, exercise, and substance use), housing stability, housing conditions, food security, and other social determinants. Finally, blood pressure, height and weight are measured using a sphygmomanometer and a scale.

The health coaching provided by CHWs involves setting of one or more SMART (specific, measurable, achievable, results-focused, and time-bound) goals with the participant, educational modules on chronic conditions, medical care visit companionship, referrals to social services, and

[123] Office of the New York City Comptroller Scott M. Stringer, Bureau of Fiscal and Budget Studies. How New York Lives: An Analysis of the City's Housing Maintenance Conditions. September 2014. https://comptroller.nyc.gov/wp-content/uploads/documents/How_New_York_Lives.pdf

[124] Next Generation NYHCHA, New York City Housing Authority. May 2015. Pages: 5-10. Available online: https://www1.nyc.gov/assets/nycha/downloads/pdf/nextgen-nycha-web.pdf

[125] Hsu J, Sircar K, Herman E, Garbe P. (2018). EXHALE: A Technical Package to Control Asthma. Atlanta, GA: National Center for Environmental Health, Centers for Disease Control and Prevention.

emergency interventions during acute-risk situations (e.g., very high blood pressure readings, mental health crises). Participants choose their specific goals and even if they have a particular chronic condition, they do not necessarily set a goal or ask for services related to that condition. CHWs also make referrals to IPM services through the East Harlem Asthma Center of Excellence and help residents advocate with NYCHA for maintenance repairs and NYCHA IPM. Following health coaching, participants are encouraged to stay engaged in HHAP through group wellness activities, peer support groups, and advocacy efforts.

Results/Outcomes

Since its inception in 2015, HHAP has enrolled 1,473 adults into health coaching. Among these, 541 self-reported an asthma diagnosis, and 217 of those with asthma reported experiencing asthma attacks or episodes in the past twelve months. The majority had public health insurance (Medicaid 51%, Dual coverage 22%, Medicare 14%, private coverage 11% and 3% not insured). Among persons with asthma, 41% of those on Medicare reported financial barriers (trouble paying co-pays, deductibles, bills, or prescription refills) compared to 11% of those on Medicaid, 16% on private insurance and 22% on dual coverage. The average age was 57 years.

<u>Comparison of Participants by Asthma Episodes Experienced in Past 12 months (P12Ms)</u>

Among participants with asthma, we compared those who had asthma attacks/episodes within the previous 12 months with those who had not in order to better understand conditions associated with asthma control in this population.

Those participants who had experienced an attack/episode in the past 12 months were more likely than those who had not to have visited an ED (64% versus 41%) or been hospitalized in the past 12 months (37% versus 21%). They were also more likely to have experienced health insurance gaps and affordability issues with a prescription, out of pocket insurance costs (e.g.co-pays), or medical bill in the past 6 months, and to have pests in their home. In particular, Medicare only participants disproportionally struggled with financial barriers (meeting copayments, deductibles, and out-of-network bills). In some cases, participants have told HHAP staff that they have skipped prescription re-fills or routine office visits and “borrowed” asthma medications from children or others. Exposure to smoke was similarly high for both groups when looking at specific sources of smoke (Table 2), however when any exposure from all sources was examined, exposure was higher for persons who had experienced an attack/episode in the past 12 months. Demographic characteristics, number of chronic health conditions, and having a primary care provider were similar between these groups.

Table 2. Baseline comparison of participants with asthma who had experienced asthma attacks/episodes in past 12 months compared to those who did not

	Asthma attack/episode in P12Ms (217)	No attack/episode in P12Ms (324)
HEALTH INSURANCE		
Health insurance gap in P12Ms*	10%	4%
Difficulty paying for a prescription*	12%	6%
Difficulty paying out-of-pocket insurance costs (e.g., co-pays & deductibles) *	14%	8%
Difficulty dealing with a medical bill**	17%	6%
Been unable to fill a prescription due to lack of money in P6Ms*	11%	4%
HOUSING CONDITIONS		
Any housing condition problem (net)	60%	59%
Home conditions (major mentions):		
Pests (roaches or rodents) *	35%	22%
Water leaks	16%	13%
EXPOSURE TO SMOKE		
Any exposure to smoke in the home: *	60%	52%
Currently smoke	32%	29%
Others in the home smoke	32%	27%
Smell of smoke comes in from outside every day	52%	50%
* P <= 0.05 ** p<= 0.01		

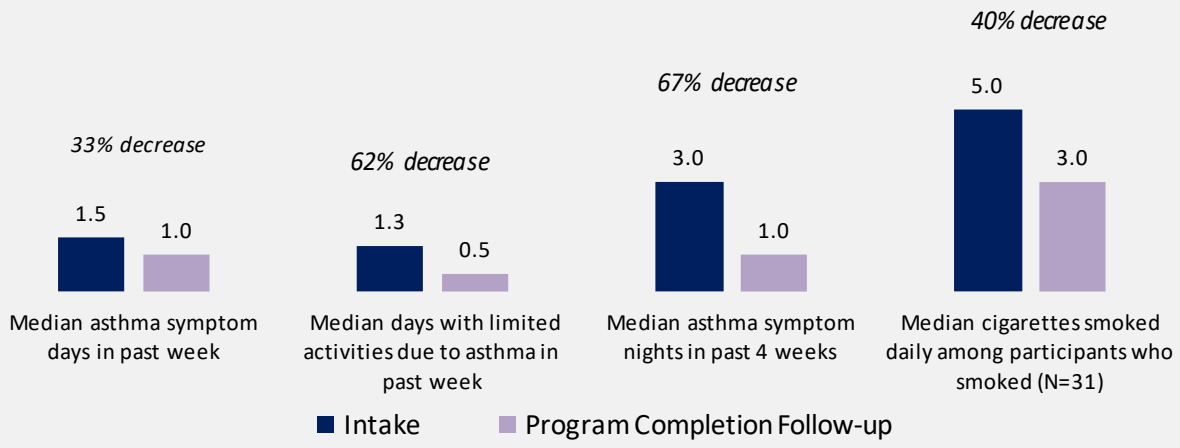
It was assessed whether participants with asthma attacks/episodes in the past 12 months experienced improvements in symptom days, days with limited activities due to asthma, symptom nights and, among those who smoked, number of cigarettes smoked daily between intake and follow-up. Analyses were first restricted to health coaching participants who had experienced asthma attacks/episodes in the past 12 months (N=217) and then further restricted to those who had completed an intake and follow-up survey (conducted approximately 6 months after intake) for a total of 133 participants. Participants were included regardless of whether they focused on asthma in health coaching or something else. According to clinical guidelines, adult asthma may be considered well controlled if the number of asthma symptom days are no more than 2 per week, nighttime symptoms are no more than 2 times a month and days where activities are limited are 0 per week. The analysis used these guideline values as cut points.

Asthma symptoms and cigarettes smoked were all non-normal in distribution. An examination of the median values show effective improvements were achieved across all four indicators between intake and follow-up (Figure 35). The median number of asthma symptom days per week decreased during intervention from 1.5 to 1.0 per week and those having symptom days within the clinical guideline for this indicator went from 66% to 75%. Median days with limited activity due to asthma decreased from 1.3 to 0.5 per week and those within the clinical guideline for this indicator went from 38% to 44%. Median nights of being woken by asthma symptoms

decreased from 3.0 to 1.0 per 4 weeks and the percent within the clinical guideline went from 47% to 67%. Among participants who smoked, median number of cigarettes smoked per day decreased from 5.0 to 3.0 and those smoking 0 cigarettes went from 6% to 23%.

Finally, stress can be another important trigger for asthma for HHAP participants.[126, 127] The impact of community disinvestment, structural racism, and other sources of toxic stress and trauma can amplify immune responses to asthma triggers. These are not reported here but also showed improvement during the program intervention.

Figure 35. Among participants with asthmaattacks/episodes in previous 12 months at intake, median asthma symptoms & cigarettes smoked at intake & follow-up (N=133)



Implementation Considerations

It is important to note that there are some limitations to the analyses detailed above. All outcomes reported here are self-reported. Data from participants was collected by the same individuals who provided the intervention, which could have led to some social-desirability bias. Additionally, fewer than half of health coaching participants with asthma focused on asthma management in health coaching which might have diluted the association between the intervention and outcomes.

Implementing the EXHALE strategies through programs such as HHAP supports families in managing their asthma and improving their symptoms, leading to an increased quality of life. However, the key factors for population wide success are structural (economic and social) reforms which lower exposure to known asthma triggers.[123,126 128]

[126] Chen E, Miller GE. Stress and inflammation in exacerbations of asthma. Brain Behav Immun. 2007;21(8):993–999. doi: 10.1016/j.bbi.2007.03.009

[127] Sternthal MJ, Jun HJ, Earls F, Wright RJ. Community violence and urban childhood asthma: a multilevel analysis. Eur Respir J. 2010;36(6):1400–1409. doi:10.1183/09031936.00003010

[128] NYC Comptroller Scott Stringer; Chen E Miller; Reinhadrt (new below)
Reinhardt, Uwe E. Priced out: The Economic and Ethical Costs of American Health Care. Princeton University Press. 2019. ISBN: 9780691192178. Pages:232.

East Harlem Asthma Center of Excellence

Overview

Childhood asthma disparities, particularly in East Harlem compared with all of NYC, are rooted in decades of racist policies. These policies created segregated neighborhoods across the city and targeted predominantly Black and Latino areas for systemic disinvestment and neglect spanning the social determinants of health (education, employment, housing, food access etc.) As a result, these policies have negatively impacted community-wide health outcomes, including elevated childhood rates of hospitalizations and emergency department visits due to asthma.

The East Harlem Asthma Center of Excellence (EHACE), situated within the NYC DOHMH Center for Health Equity and Community Wellness, is a neighborhood asset, which supports children and families who are disproportionately impacted by asthma and its triggers. EHACE's flagship Asthma Counselor Program (ACP) is one of several community-based components designed to address childhood asthma. Other Asthma Initiative components include:

- Integrated Pest Management (IPM)
- Community Health Worker Asthma Program (asthma case management)
- Asthma Daycares Program (early identification of children with asthma)
- Open Airways in Schools (asthma training for school nurses)
- NYC Asthma Network (advocacy, policy, partnerships)

These programs support both the immediate and long-term needs of children and their families to improve asthma outcomes and reduce their triggers. More specifically, ACP's multi-dimensional programming is designed to improve access to care and other social services; increase self-efficacy in asthma self-management, including asthma medications and devices; reduce home environmental triggers through home visits and other services; create linkages between families and medical providers; forge and sustain partnerships to advance policy solutions that will benefit affected children and their families; and raise awareness of asthma and its triggers among the larger community serving children (i.e., schools and daycares). EHACE's Asthma Counselor Program (ACP) and IPM programs are featured below.

Description

The ACP, modeled after the National Cooperative Inner-City Asthma Study[129], uses masters-level social workers (MSW) to deliver individualized asthma care management and education, provide home visits to identify indoor asthma triggers, provide community social service referrals, and create linkages and coordination of asthma care. Children are eligible if they are connected to East Harlem (i.e., reside in, attend school in, or receive medical care in East Harlem), are under 19 years of age, and have asthma that is not well-controlled. Since its inception, ACP has enrolled more than 1,500 children in the program. Children enroll in ACP in a variety of ways. Counselors are stationed at the EHACE office in East Harlem and recruit families through community

[129] Evans R, Gergen P, Mitchell H, Kattan M, Kercsmar C, Crain E, Anderson J, Eggleston P, Malveaux F, Wedner H. A randomized clinical trial to reduce asthma morbidity among inner-city children: Results of the National Cooperative Inner-City Asthma Study. The Journal of Pediatrics; 1999; 135 (3): 332-338.

outreach activities, such as connecting with local schools, CBOs, and health care providers. Families also self-refer to the program, often hearing about ACP through word-of-mouth or from health care providers in the community. Additionally, two asthma counselors are stationed at neighborhood hospitals and recruit children served through the ED or as an inpatient due to asthma. Through partnerships with CBOs and clinical engagements, the ACP program has an active referral network of over 50 organizations, including local schools, daycares, federally qualified health centers, and also conducts outreach at local events and workshops.

When children enroll in the program, counselors meet with families for an in-depth, in-person assessment. During this time, counselors discuss the child's asthma history, symptoms, triggers, and medications, and assess asthma-related outcomes, including missed school days, recent hospitalizations, and ED visits. Based on needs identified, counselors provide referrals for the child or the larger family unit for a variety of social services (i.e., housing, mental health, food insecurity, immigration, legal). Counselors provide asthma-related supplies such as mattress and pillow covers, air purifiers, asthma spacers, and asthma literature to help children and families better manage their child's asthma at home. Additionally, counselors provide one-on-one asthma education with the family (i.e., triggers, symptoms), establish goals with the family to achieve positive asthma outcomes, review medications with the family, and discuss the child's Asthma Action Plan (AAP) and the Medication Administration Form (MAF). If the family does not have an AAP or MAF, counselors work with the family, school, and medical staff to complete the forms, which are important resources for managing the child's asthma while at school. Counselors serve families using motivational interviewing techniques and identify barriers to chronic disease management and other psychosocial issues that may prevent optimal asthma management.

Counselors provide care coordination by connecting families to primary care (if they have none), assisting families in navigating the health care system, providing referrals to specialty care, following up on barriers to health care access, and advocating for appropriate asthma medication management. Counselors also notify the school nurse, primary care provider, or daycare staff when a family is enrolled to keep all stakeholders engaged in a patient-centered model of care. ACP counselors recognize that children are part of a larger family and therefore work with parents, grandparents, guardians and other relatives and social supports throughout the child's enrollment and will make referrals for anyone in the family unit, not only the enrolled child. Follow-up appointments are conducted every 3 months, but counselors maintain contact with families throughout their enrollment to provide additional coaching and referrals. At follow-up appointments, counselors review many of the topics discussed during the intake appointment to assess progress and identify areas for improvement, such as changes in medications, AAP, MAF, as well as whether the child had any recent hospitalizations, ED visits, or missed school days. Children are typically enrolled in the program for approximately one year.

Counselors also conduct monthly group wellness activities for enrolled families and families who have completed the program, including art and crafts classes to engage children and parents in a group setting. This also allows families to meet, engage, and build community, as well as address stress, a known asthma trigger. In 2018, over 700 children and adults participated in these types of events. These services can help to address stress which is also an asthma trigger.

IPM services provide home improvements to residents in private buildings and public housing in Bronx, Brooklyn, Manhattan, Queens, and Staten Island to promote healthy and safe housing and reduce known indoor environmental asthma triggers. IPM is a process for achieving long-term, environmentally sound pest reduction using a range of pest control methods, including green cleaning, pest removal, and minor structural alterations rather than relying on pesticides. IPM services are founded on previous research about this approach to reduce pest allergen exposures.[130, 131] This approach focuses on improving sanitary and structural conditions by reducing pests and their access to food, water, and movement within the home. In NYC Fiscal Year 19 (July 2018-June 2019), 109 IPMs were provided to families, with more than one-half of those families coming from the ACP.

IPM services are available to families enrolled in any of the Asthma Initiatives, including our ACP, Daycares program, and Community Health Worker Asthma program, thereby complementing these asthma programs to address indoor exposure to asthma-triggers. Families are also eligible if they are enrolled in our Harlem Health Advocacy Partners program, a program that addresses many health conditions, including asthma, among adults living in public housing in East Harlem. Once a family receives an IPM referral, EHACE staff contacts the family to schedule the IPM appointment. EHACE staff notify the IPM vendor about the scheduled appointment and provide the necessary information to complete the appointment. Additionally, EHACE staff place a reminder call to the family at least one day before the IPM appointment.

During the IPM visit, the vendor inspects the home for evidence of asthma triggers, such as mice and cockroaches. Based on the inspection, the vendor then addresses the triggers through a variety of activities, including using a high efficiency particulate air (HEPA) vacuum to better capture microscopic particles, sealing pest entry holes, and applying Boric acid into cracks or crevices around cabinets and pipes. The vendor also provides green-cleaning education to avoid strong chemical odors or other harsh irritants that may contribute to asthma triggers, and general education that offers tips for removing pest entryways into the home. EHACE staff follow-up with families to ensure the visit was completed and the family is satisfied with the service. Given the demand for IPM services, families are eligible for only one IPM service.

Results/Outcomes

The ACP's primary outcomes include reduced hospitalizations, ED visits, and missed school days because of asthma. EHACE staff published an Epi Data Brief[132], a NYC DOHMH publication, about

[130] Brenner BL, Markowitz S, Rivera M, Romero H, Weeks M, Sanchez E. Integrated pest management in an urban community: a successful partnership for Prevention; Environmental Health Perspective; 2003; 111:1649-1653.
[131] McConnell R, Milam J, Richardson J, Galvan J, Jones C, Thorne PS. Educational intervention to control cockroach allergen exposure in the homes of Hispanic children in Los Angeles: results of the La Casa study. Clinical and Experimental Allergy; 2005;35:426–433.
[132] Wang H, Dannefer R, Brown-Dudley L, et al. Childhood asthma and the asthma counselor program of the East Harlem Asthma Center of Excellence. New York City Department of Health and Mental Hygiene: Epi Date Brief (90); June 2017.

ACP and its asthma outcomes (June, 2017). More than 450 families graduated from ACP between 2008 and 2016. Of the 45 children who graduated in 2016: (1) the total number of asthma-related ED visits in the previous 12 months declined 56% from 66 at baseline to 29 at final follow-up; (2) the number of children having two or more asthma-related ED visits in the previous 12 months decreased from 16 at baseline to five at final follow-up, and (3) the total number of asthma-related hospitalizations in the previous 12 months decreased from 10 at baseline to five at final follow-up. EHACE staff have continued to monitor these asthma outcomes and found similar improvements among subsequent participants.

The IPM program's primary outcomes include assessing family satisfaction with the IPM service and whether their IPM-related issues have been resolved. In Fiscal Year 19, 85 families were surveyed about their experiences receiving an IPM visit. On a scale of one to five—from completely dissatisfied to completely satisfied—all families rated their level of satisfaction as either completely satisfied (95%) or satisfied (5%). Additionally, regardless of presence of rodents, roaches, or both, all families noted fewer pests in the home at the time of follow-up.

Implementation Considerations

Some of the key factors to our programs' successes include:

- Building off previous evidence of family-centered asthma programming for children
- Maintaining a strong and dependable presence in the community to build relationships with families
- Developing and sustaining a robust network of other NYC government agencies, CBOs, schools, and hospitals committed to improving childhood asthma outcomes
- Using a multi-pronged approach to address asthma and health equity
- Addressing and reducing home environmental asthma triggers
- Using masters-level social workers to address family challenges with multiple stressors
- Having bilingual staff
- Having long-term financing for these programs to retain a qualified workforce and establish long-term relationships with partners and the community

Housing conditions remain a primary barrier to obtaining a safe allergen-free or asthma-trigger-free home environment. Substandard housing conditions are a result of policies such as redlining and decades of disinvestment that continue to affect low-income communities, including East Harlem.

As with any program, sustainability and spread and scale remain critical issues to be addressed, including:

- Funding sources
- Expansion and replication of this model
- Flexibility in modifying program protocols based on program data, staff feedback, and clients' experiences

NYC Healthy Homes Program

Overview
In NYC, Local Law 55 of 2018 requires that owners of buildings with three or more apartments or buildings of any size where a tenant has been medically diagnosed with moderate persistent or severe persistent asthma- keep their tenants' apartments free of mold and pests. This includes safely fixing the conditions that cause these problems. NYC DOHMH's Healthy Neighborhoods Program (HNP) provides free home assessments to NYC resident children and adults diagnosed with moderate or severe persistent asthma by a health care provider. If HNP inspectors find environmental asthma triggers, such as cockroaches, mice or mold, or other home health hazards, the program will work with building owners to correct the problems. Key activities include assessment, inspection, code enforcement, referrals, education, and evaluation.

Description
Local Law 55 requires that landlords of residential buildings with three or more apartments – or buildings of any size where a tenant has been medically diagnosed with moderate persistent or severe persistent asthma– take steps to keep tenant homes free of pests (cockroaches and rodents) and mold. This includes safely fixing the conditions that cause these problems (e.g., water leaks, cracks/holes, etc.). The law is co-enforced by the NYC Department of Housing Preservation and Development (HPD), which goes into any private buildings with 3+ apartments, and NYC DOHMH, which goes into any type of residential building if there's a person with medically diagnosed moderate persistent or severe persistent asthma.

NYC DOHMH's HNP is responsible for responding to referrals received from health care providers for NYC tenants with medically diagnosed moderate persistent or severe persistent asthma who report pests or mold in the home. Medical providers can submit referrals either online, through the Citywide Immunization Registry (CIR), or by faxing a completed asthma referral form to NYC DOHMH.

During the initial home assessment, a NYC DOHMH inspector will look for pests and mold and the problems that lead to them. If problems are found, the NYC DOHMH uses its authority under the NYC Health Code to require the building owner to safely address such conditions. The building owner will have 21 days to make needed repairs. After 21 days, the inspector will return to the home to see if the problems were fixed. If the building owner has not finished fixing the problem but is making progress, they will be given more time to make repairs. If the building owner is not fixing the problem, HNP may issue a Notice of Violation, which can result in a fine. HNP may also refer non-compliant building owners to HPD for potential follow up via the Emergency Repair Program (ERP), where HPD will make the repairs, and bill the building owner for the work.

The program is funded through the NYS HNP and by city tax levy funding.

Results/Outcomes

From April 2018 through March 2019, NYC HNP successfully assessed almost 500 homes initiated by referrals submitted from 45 different health care providers on behalf of children with asthma. NYC HNP staff confirmed the presence of pests and other housing hazards in over 400 of the homes assessed (88%). During this period, NYC HNP issued over 350 (87% of the homes) Commissioner's Order to Abate (COTA) for pest allergen hazards, or conditions conducive to pests. Of the over 280 follow-up visits conducted to check on work progress after 21 days, 94% of homes were found to either be in compliance or making progress towards compliance.

Relevant Publications:

1. Local Law 55 fact sheet for landlords and tenants
2. Environmental home visits fact sheet for tenants with persistent asthma
3. Training curriculum on safe work practices for removing pest and mold allergens for building owners and maintenance staff

Implementation Considerations

Beginning in January 2019, as a result of Local Law 55 going into effect, NYC HNP expanded its program to receive referrals for adults diagnosed with moderate or severe persistent asthma, and referrals for eligible households with mold conditions, regardless of the presence of pests. The program continues to conduct quality improvement to ensure that it is providing comprehensive services and connecting families to resources when appropriate. In addition, fire safety, mold assessment and asthma educator trainings are provided for program staff members.

NYC DOHMH is also surveying health providers to assess the ease with which patient referrals can be submitted for home assessments. NYC DOHMH may revise/improve its referral process as a result of any challenges identified from the survey.

Recommendations

The Department's and NYC DOHMH's dedication to maintaining a robust asthma surveillance system including the NYS Asthma Dashboard and NYC's Epi Query are essential to planning, monitoring, and evaluating major asthma-related interventions and initiatives. Asthma surveillance and evaluation play a key role in guiding efforts to effectively target resources, develop programs, inform policy, and educate stakeholders and partners. The following recommendations support the goals of NY's Prevention Agenda and NYS Medicaid health care reform efforts. Recommendations are categorized by community, environmental, and health systems focused approaches and seek to further coordinated efforts across schools, health systems, and community-based partners to expand the delivery of quality asthma care to NY's highest risk populations. NY's success in advancing the recommendations outlined relies heavily on multi-sector collaboration. Buy-in and engagement from elected officials and government, health care providers and payers, statewide associations, community-based organizations, and individuals, families and communities are vital.

Community Focused Approaches

- Continue efforts to integrate and sustainably fund CHWs, school nurses, home visiting nurses, and certified asthma educators (AE-Cs) to deliver individually tailored, culturally responsive ASME across home-, school- and community-based settings.
- Actively promote the adoption and use of evidence-based policies supportive of asthma control across sectors, particularly in communities of color.
- Provide sufficient support of the NYS Asthma Management in Schools Initiative to ensure statewide school adoption of comprehensive asthma management programs for students with asthma which support medication adherence and include ASME and reduction of environmental asthma triggers.
- Engage local health departments and communities to participate in efforts to achieve asthma-related objectives outlined in NY's Prevention Agenda.
- Expand awareness about the risks of SHS exposure to individuals with asthma and encourage partnering organizations to refer people who smoke to appropriate cessation interventions and to their primary care provider for counseling and cessation medications.
- Strengthen linkages between community-based partners (including schools) and health care to ensure coordination of and access to guidelines-based asthma care among communities facing health disparities.
- Maintain and expand asthma-related communication efforts and health education for health care providers and individuals with asthma and their families. Engage communities to identify related needs and preferred approaches for receiving information.
- Strengthen statewide and local anti-smoking, vaping, and e-cigarette restrictions.
- Improve community access to heating and cooling assistance among NYS residents.
- Expand availability and accessibility of cooling centers in high-risk communities.
- Work with local National Weather Service Offices to ensure vulnerable populations receive heat alerts and cooling center information.

Environmental Focused Approaches

- Improve housing quality and reduce asthma triggers by expanding adoption, implementation, and enforcement support for State and local policies such as NYC Local Law 55 which requires maintenance deficiencies to be addressed in a timely manner for individuals suffering from a respiratory condition such as asthma.
- Ensure sustainable funding for comprehensive healthy homes services which integrate asthma home-based services with energy efficiency, weatherization, and home safety services to maximize cross-sector collaboration and efficiencies.
- Expand NYS Healthy Neighborhoods Program (HNP) to operate in every high asthma burden county statewide.
- Strengthen local building codes to require balanced ventilation and compartmentalization within multi-family housing units to prevent SHS infiltration from neighboring units.
- Increase efforts to support and enforce NYCHA's smoke-free housing policy and improve access to smoking cessation services among public housing residents.
- Expand access to and promote the use of IPM to address pest problems while minimizing impacts on health of residents and the environment.
- Avoid planting tree and shrub types that have greater allergenic pollen potential near playgrounds and senior community centers.
- Expand the public's awareness of Air Quality Health Alerts, and what they should do when one is issued to avoid a well-known asthma trigger.

Health Systems Focused Approaches

- Build NYS regional asthma contractors' capacity to implement *Project BREATHE NY* in every high asthma burden community statewide. This would enable strategic partners to:
    - Harness NY's ongoing health care reform initiatives under the MRT Waiver, the NYS Roadmap for Medicaid Payment Reform, and the NYS Health Equity Reform 1115 Waiver Amendment application to drive statewide dissemination and adoption of *Project BREATHE NY.*
    - Encourage health systems, health plans, and CBO investment in CDC's evidence-based EXHALE strategies shown to reduce avoidable asthma-related health care utilization across.
    - Promote uptake of a standard set of asthma measures across health systems statewide to monitor improved patient outcomes and facilitate asthma quality improvement.
    - Expand patient care coordination across clinical, school, home, and community-based settings.
    - Strengthen health care provider capacity to collaborate with cross-sector partners that address SDH needs including services which improve home energy efficiency such as home weatherization assistance programs for low-income families.
    - Promote shared decision making which prioritizes patient and family input and engagement, recognizes family needs related to SDH, and acknowledges cultural diversity and the sustaining impacts of structural racism.

- Employ systems-level strategies and policies to support integration of comprehensive, guidelines-based asthma care services across NY's health care delivery system to:
    - Promote delivery of ASMT and expand coverage to include services delivered in any setting by certified asthma educators (AE-C).
    - Expand use of home skilled nursing visits to deliver comprehensive home-based asthma services (including ASME and trigger reduction) for pediatric patients whose asthma is not well controlled. Ensure availability of and patient access to these services by allowing standing orders for home-based asthma visits at discharge from asthma-related ED visits/hospitalizations.
    - Provide coverage for CHWs formally trained in conducting evidence-based home asthma visits to build on promising practices identified through DSRIP's Asthma Projects.
    - Eliminate barriers to obtaining asthma medications and devices (e.g., co-payments, prior authorization, or refill limits) and align formularies in the NYS Medicaid pharmacy carveout to support guidelines-based prescribing recommendations.
    - Ensure every patient has a written asthma action plan and for NYC students, a Medication Administration Form (MAF), to provide necessary permissions/approvals for asthma medication management at school.
    - Develop and strengthen bidirectional data sharing and referral systems for linking patients and families to clinical, school-, home-, and community-based asthma providers and organizations addressing SDH (e.g., transportation to medical appointments, IPM, home weatherization assistance programs, tenant advocacy, etc.).
- Continue to invest in the NYS Children's Environmental Health Centers to expand existing initiatives and leverage new opportunities that support patient and provider education, policies supportive of asthma control, and partnerships dedicated to reducing the burden of asthma.

Conclusion

Tackling the burden of asthma requires continued advancements in public policy, health care, research, and focused, community-based efforts to directly address the disproportionate impact of asthma on communities of color. The report reviews asthma disparities in NYS and serves as a statewide call to action to address the social and health inequities caused by structural racism and poverty that continue to plague vulnerable, at-risk children and families living with asthma. Recommendations outlined integrate multiple strategies with strong evidence and demonstrated ROI shown to successfully improve asthma-related health outcomes, reduce avoidable health care costs, improve quality of life, and reduce morbidity and mortality caused by asthma. These evidence-based and promising best practice recommendations centering on community, schools, the environment, health systems, housing, and energy, warrant careful review and prioritization by State and local level public and private sector leaders.

Successful, coordinated implementation of recommendations in this report will require prioritizing sustainable resources dedicated to addressing the burden of asthma in NY, including: ensuring adequate Federal and State resources for the NYSACP to lead and coordinate Department and cross-agency efforts to expand implementation of CDC's EXHALE strategies and conduct statewide asthma surveillance and evaluation activities; restoring funding to rebuild NYS asthma contractor capacity to serve children with asthma across all of NY's high asthma burden counties; securing additional resources to effectively reach target populations disproportionately burdened by asthma including Black and Hispanic children and children living in poverty; and, driving innovative solutions through multi-sector collaboration and investment across partners and key stakeholders with a shared mission to save lives and improve communities. Together, NY can work quickly to elevate statewide solutions which are vital to ending the needless suffering caused by asthma and emerge as a national leader in fighting the harm and unequal burden of this disease shouldered by NY's most vulnerable children and families.

Asthma Related Resources

National Asthma Education and Prevention Program (NAEPP): Guidelines for the Diagnosis and Management of Asthma Focused Updates 2020
https://www.nhlbi.nih.gov/health-topics/asthma-management-guidelines-2020-updates

National Asthma Education and Prevention Program (NAEPP): Guidelines for the Diagnosis and Management of Asthma 2007 (EPR-3)
https://www.nhlbi.nih.gov/health-topics/guidelines-for-diagnosis-management-of-asthma

Global Initiative for Asthma (GINA)
https://ginasthma.org/wp-content/uploads/2018/04/wms-GINA-2018-report-V1.3-002.pdf

Asthma Community Network
http://www.asthmacommunitynetwork.org/

Community Guide to Preventive Services
https://www.thecommunityguide.org/

CDC 6/18 Initiative
https://www.cdc.gov/sixeighteen/asthma/index.htm

American Lung Association's Open Airways for Schools
https://www.lung.org/lung-health-and-diseases/lung-disease-lookup/asthma/asthma-education-advocacy/open-airways-for-schools/

American Lung Association's Kickin' Asthma
https://www.lung.org/lung-health-and-diseases/lung-disease-lookup/asthma/asthma-education-advocacy/kickin-asthma.html

NYC Local Law 55
https://www1.nyc.gov/assets/buildings/local_laws/ll55of2018.pdf

NYC Local Law 43-2010 NYC and NYC DEP Rule (May 2011)
https://www.edf.org/sites/default/files/newyork-laws-regulating-heating-oil.pdf

NYS Healthy Neighborhood Program
https://www.health.ny.gov/environmental/indoors/healthy_neighborhoods/

NYS Guide for Asthma Management in Schools
https://www.health.ny.gov/publications/5163.pdf

NYS Children's Environmental Health Centers
https://nyscheck.org/

NYS Asthma Dashboard
https://webbi1.health.ny.gov/SASStoredProcess/guest?_program=/EBI/PHIG/apps/asthma_dashboard/ad_dashboard&p=sh

NYC Open Data
https://opendata.cityofnewyork.us/data/

Appendix A – Methods and Data Sources

More about United Hospital Fund-42 neighborhoods

UHF-42 neighborhoods are aggregations of ZIP codes. These areas allows local leaders and the public to view characteristics of their neighborhood and asses their community's needs and assets.[133, 134] The UHF-42 map can be found here: http://a816-dohbesp.nyc.gov/IndicatorPublic/EPHTPDF/uhf42.pdf. The following link can be used to see which ZIP codes are contained within each UHF-42 neighborhood: https://www1.nyc.gov/assets/doh/downloads/pdf/ah/zipcodetable.pdf.

More about Asthma data summaries

Asthma hospitalization and ED visit data was obtained from the New York State Statewide Planning and Research Cooperative System (SPARCS) [135]. SPARCS collects information on patient characteristics, diagnoses and treatments, services, and charges for each hospital inpatient stay and outpatient visit at non-federal hospitals in NYS. These data were used to calculate crude and age-adjusted ED visit rates for geocoded cases (ICD-9 Code for principal diagnosis code: 493). For all rate calculations using SPARCS data, asthma cases were assigned to geographic areas based upon the residential address. Total population for each geographic area was calculated using data available from the Census.

Asthma prevalence was obtained using the Behavioral Risk Factor Surveillance System (BRFSS) Survey. The BRFSS surveillance survey is conducted annually in all 50 states and US territories. The objective of the BRFSS is to collect uniform, state-specific data on preventive health practices and risk behaviors that are linked to chronic diseases, injuries, and preventable infectious diseases.

More about Sociodemographic Disparities assessment

The BRFSS collects information on various socio-demographic factors including gender, race, education level and income. Prevalence rates for both adults and children in New York were compared to these socio-demographic factors to produce bar charts that demonstrate variation in prevalence.

Data from the 2007-2011 American Community Survey (ACS) were used to define low-income and non-low-income ZIP Codes. Using the five-year estimates from ACS, ZIP Codes that have greater than or equal to 20% of population in poverty are defined as low-income ZIP Codes, and ZIP Codes that have less than 20% of population in poverty are defined as non-low-income ZIP Codes.

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[133] United Hospital Fund. *Improving Health Care for Every New Yorker*, <https://uhfnyc.org/> (2018).
[134] United Hospital Fund. *NYC UHF 42 Neighborhoods (Map)*, <http://a816-dohbesp.nyc.gov/IndicatorPublic/EPHTPDF/uhf42.pdf> (2019).
[135] New York State Department of Health. *Statewide Planning and Research Cooperative System (SPARCS)*, <https://www.health.ny.gov/statistics/sparcs/> (2019).

More about Indoor and Outdoor Environmental Triggers and Allergens

The assessment of indoor triggers and allergens was facilitated by existing survey data collected by NYC agencies. This information has been organized in a single "Asthma and the Environment" datasets, which is publicly available at http://a816-dohbesp.nyc.gov/IndicatorPublic/BuildATable.aspx. The "Asthma and the Environment" dataset includes data from the NYC HVS and the NYC CHS. Data on housing characteristics, including maintenance deficiencies (leaks, dampness, structural damage), and pest sightings (cockroaches, rodents) was from the NYC HVS. Data on reports of indoor mold and secondhand smoke exposure was from the NYC CHS. Data for all UHF-42 neighborhoods was organized into quartiles to summarize in thematic maps. Quartile distributions break the data into four equal portions, with the first quartile containing the lowest values and the fourth quartile the highest values in the dataset.

- NYC CHS: This is a cross-sectional telephone survey with self-reported data of approximately 10,000 randomly selected adults (18 years and above) from all 5 NYC boroughs. Data on indoor mold, secondhand smoking exposure that was reported in the CHS, was obtained from the "Asthma and the Environment" dataset available on the NYC DOHMH Environment & Health Data Portal at http://a816-dohbesp.nyc.gov/IndicatorPublic/Subtopic.aspx
- NYC HVS 2014: collects data on building/unit condition including presence of pests, leaks, cracks and holes, and general condition of neighboring building. The NYC HVS is conducted every three years through a partnership between the UHUD and the US Census Bureau.[136] Approximately 18,000 housing units (including occupied and unoccupied units) across all 5 NYC boroughs are visited by trained field representatives from all 5 NYC boroughs to complete the questionnaire. Original HVS data is available at: http://www.census.gov/hhes/www/housing/nychvs/nychvs.html. Data on housing conditions for this report was obtained from "Housing" indicator on the NYC DOHMH Environment & Health Data Portal available at http://a816-dohbesp.nyc.gov/IndicatorPublic/Subtopic.aspx

Public Housing

NYCHA: Information on Public housing distribution and population was obtained on January 1, 2016 from the NYCHA Resident Data Files including Section 8 Transition and Public Housing Units in the Tax Credit Developments (LLC1) and Non-Tax Credit Developments (LLC2) developments. The NYCHA Development Data and Data book were obtained from NYC Open Data accessed in March 2018 and available at https://data.cityofnewyork.us/Housing-Development/NYCHA-Development-Data-Book/evjd-dqpz. More information on NYCHA developments is available at https://www1.nyc.gov/assets/nycha/downloads/pdf/pdb2019.pdf.

[136] New York City Housing Preservation and Development. *New York City Housing and Vacancy Survey(NYCHVS)*, <https://www1.nyc.gov/site/hpd/about/nychvs.page> (2014).

Public housing properties were overlaid onto UHF-42 neighborhoods. To better understand the total population living in public housing properties in each neighborhood, we determined the total population living in each UHF-42 by aggregating 2010 US Census Bureau ZIP Code Tabulation Areas (ZCTA) [137] within each UHF-42 area. We calculated the percent UHF-42 population in public housing by summing the population in all public housing units within a UHF-42 and dividing by the total UHF-42 population as calculated above (See Appendix B). To estimate asthma prevalence in and outside of public housing, we geocoded asthma cases from SPARCS from 2008-2012 among NYC residents calculated the sum of asthma cases falling within the boundary of a public housing footprint for each UHF-42 neighborhood. Similarly, cases mapped outside of the public housing footprints were summed within each UHF-42 to estimate number of cases living outside public housing. Crude asthma rates (per 10,000) among public housing residents reflect dividing the number of asthma cases in public housing by the total population in PH within each UHF. Crude asthma rates within a UHF-42 are the sum of cases in each UHF-42 divided by the aggregated zip code populations described above. Measures explored in this report include: percent of UHF-42 asthma cases living in public housing, asthma rate difference between cases within and outside of public housing; relationship between percent UHF-42 population living in public housing and UHF-42 asthma rate.

Outdoor air quality and allergens

DEC ambient air monitoring data was obtained using data from www.dec.ny.gov/chemical/8406.html, and from the Bureau of Air Quality Surveillance in the Division of Air Resources.

Permitted facility data was obtained using https://gisservices.dec.ny.gov/gis/dil for Title Five and State Facility Permits and from Division of Air Resources for Registered facilities.

Traffic data from 2016 was obtained from the Department of Transportation website (https://www.dot.ny.gov/divisions/engineering/technical-services/highway-data-services/hdsb). The traffic counts from monitoring locations within each UHF-42 region were summed and then divided by the area (in square miles), of the region. We divided the regions were divided into five groups, based on the annual average daily traffic counts per square mile.

Meteorological Factors

Temperature and precipitation data were obtained from the historical meteorological data maintained by the National Oceanic and Atmospheric Administration's (NOAA) as observed at the monitoring station in Central Park.[138, 139]

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[137] US Census Bureau. *ZIP Code Tabulation Areas (ZCTAs).* https://www.census.gov/programs-surveys/geography/guidance/geo-areas/zctas.html (2010).

[138] National Oceanic and Atmospheric Administration. Annual and Monthly Precipitation at Central Park by Year (1869-2018). <https://www.weather.gov/okx/CentralParkHistorical> (2019).

[139] National Oceanic and Atmospheric Administration. Annual and Monthly Precipitation at Central Park by Year (1869-2018). <https://www.weather.gov/okx/CentralParkHistorical> (2019).

Annual mean temperatures and annual and monthly precipitation data from 1869 to 2018 to observe trends over the years. Data and more information can be found here https://www.weather.gov/okx/CentralParkHistorical

The National Allergy Bureau (NAB), a section of the American Academy of Allergy, Asthma and Immunology's Aeroallergen Network, oversees a pollen monitoring network and certifies pollen counters who operate counting stations across the United States.[140] Currently, there are four NAB counting stations in NYS that provide information about daily tree, grass and weed pollen counts. The NAB stations use pollen counts to report pollen levels as low, medium, high, or very high. The pollen reports are available through the NAB website (see www.aaaai.org/ global/nab-pollen-counts.aspx), the Weather Channel and some local news media. Daily pollen count by species, dates of pollen data collection and certain characteristics of pollen season from 2010-2018 from a current NAB pollen monitoring station at Fordham College at Lincoln Center in Manhattan (Station Head: Guy Robinson, PhD). These data were used to calculate average monthly and annual pollen counts by plant type (I.e., tree, weed or grass pollen). Length of pollen season was estimated by the 90 percentile method which defines start date as the day in which cumulative pollen count reaches 5% of the total annual pollen sum and the end date as the day in which 95% of the total annual sum is reached. Dates of pollen collection were also used to estimate the numbers of "high" and "very high" pollen days as classified by NAB for each year.[141]

[140] American Academy of Allergy Asthma & Immunology. *Pollen Definition | AAAAI*, <www.aaaai.org/conditions-and-treatments/conditions-dictionary/pollen>

[141] American Academy of Allergy Asthma & Immunology. *Pollen Definition | AAAAI*, <www.aaaai.org/conditions-and-treatments/conditions-dictionary/pollen>

Appendix B –Population counts and crude asthma rates in and outside of public housing by UHF-42

UHF-42 code	UHF-42 name	Borough	Cases outside public housing	Cases in public housing	Population outside public housing	Population in public housing	Crude rate per 10000 outside public housing	Crude rate per 10000 in public housing
101	Kingsbridge - Riverdale	Bronx	3985	356	89383	4580	89.2	155.5
102	Northeast Bronx	Bronx	12779	1671	177892	10924	142.9	305.9
103	Fordham - Bronx Park	Bronx	26929	402	245822	4863	220.3	165.3
104	Pelham - Throgs Neck	Bronx	27667	978	272750	23806	202.9	82.2
105	Crotona - Tremont	Bronx	35102	1279	199127	5924	351.7	431.8
106	High Bridge - Morrisania	Bronx	34367	3150	177716	31999	386.9	196.9
107	Hunts Point - Mott Haven	Bronx	23942	3272	113902	21805	417.9	300.1
201	Greenpoint	Brooklyn	4472	265	120042	6350	74.5	83.5
202	Downtown - Heights - Slope	Brooklyn	8015	4246	195570	24567	79.4	345.7
203	Bedford Stuyvesant - Crown Heights	Brooklyn	37747	3993	281253	32696	268.4	244.3
204	East New York	Brooklyn	22813	1613	168251	20001	268.6	161.3
205	Sunset Park	Brooklyn	5402	0	127138	0	85.0	0.0
206	Borough Park	Brooklyn	5717	0	322315	0	35.5	0.0
207	East Flatbush - Flatbush	Brooklyn	24765	47	307770	338	160.9	278.1
208	Canarsie - Flatlands	Brooklyn	10626	819	185219	7973	115.9	205.4
209	Bensonhurst - Bay Ridge	Brooklyn	3424	0	201391	0	34.0	0.0
210	Coney Island - Sheepshead Bay	Brooklyn	7214	1263	266795	18021	54.1	140.2
211	Williamsburg - Bushwick	Brooklyn	24926	5506	187442	25460	265.6	432.5
301	Washington Heights - Inwood	Manhattan	17620	194	244319	4536	144.1	85.5
302	Central Harlem - Morningside Heights	Manhattan	27905	1974	130900	29777	425.7	132.6
303	East Harlem	Manhattan	17854	4679	81403	30984	438.7	302.0
304	Upper West Side	Manhattan	7184	1025	209327	10369	67.3	197.7
305	Upper East Side	Manhattan	2928	185	216516	2384	27.0	155.2
306	Chelsea - Clinton	Manhattan	4052	632	138017	5273	58.7	239.7
307	Gramercy Park - Murray Hill	Manhattan	2996	392	132557	995	45.2	787.9
308	Greenwich Village - Soho	Manhattan	880	0	83589	0	21.1	0.0
309	Union Square - Lower East Side	Manhattan	9044	2269	171801	26812	105.3	169.3
310	Lower Manhattan	Manhattan	1457	112	48919	4238	59.6	52.9
401	Long Island City - Astoria	Queens	5718	2342	189474	14189	60.4	330.1
402	West Queens	Queens	15795	206	470317	2961	67.2	139.1
403	Flushing - Clearview	Queens	4683	125	258446	1819	36.2	137.4
404	Bayside - Little Neck	Queens	1139	0	87353	0	26.1	0.0
405	Ridgewood - Forest Hills	Queens	6896	7	245246	799	56.2	17.5
406	Fresh Meadows	Queens	2823	57	91183	4286	61.9	26.6
407	Southwest Queens	Queens	13090	0	265461	0	98.6	0.0
408	Jamaica	Queens	19169	890	287465	3897	133.3	456.8
409	Southeast Queens	Queens	8624	0	194559	0	88.6	0.0
410	Rockaway	Queens	7367	1216	105076	9902	140.2	245.6
501	Port Richmond	Staten Island	5914	266	67092	3089	176.3	172.2
502	Stapleton - St. George	Staten Island	7205	818	119072	5167	121.0	316.6
503	Willowbrook	Staten Island	2056	6	84934	1007	48.4	11.9
504	South Beach - Tottenville	Staten Island	3926	80	187419	950	41.9	168.4

Appendix C – NYSDEC air monitoring sites and trends in criteria air pollutants

Figure C1- Locations of NYSDEC air monitoring sites as of 2018.

Figure C2- Average annual NO2 concentrations by county, 1988-2018

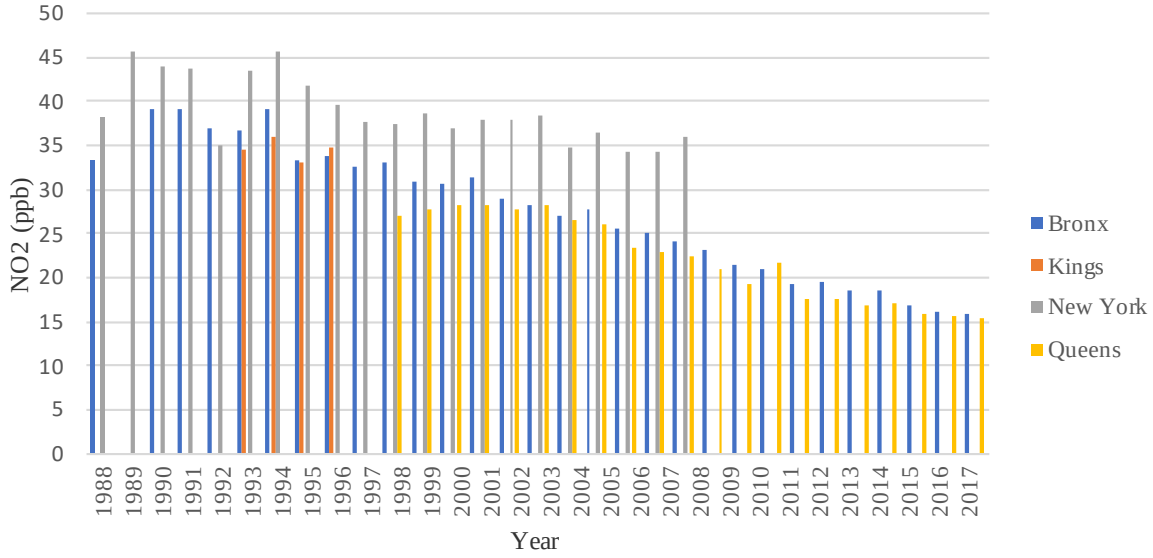


Figure C3- Average annual SO2 concentrations by county, 1988-2018

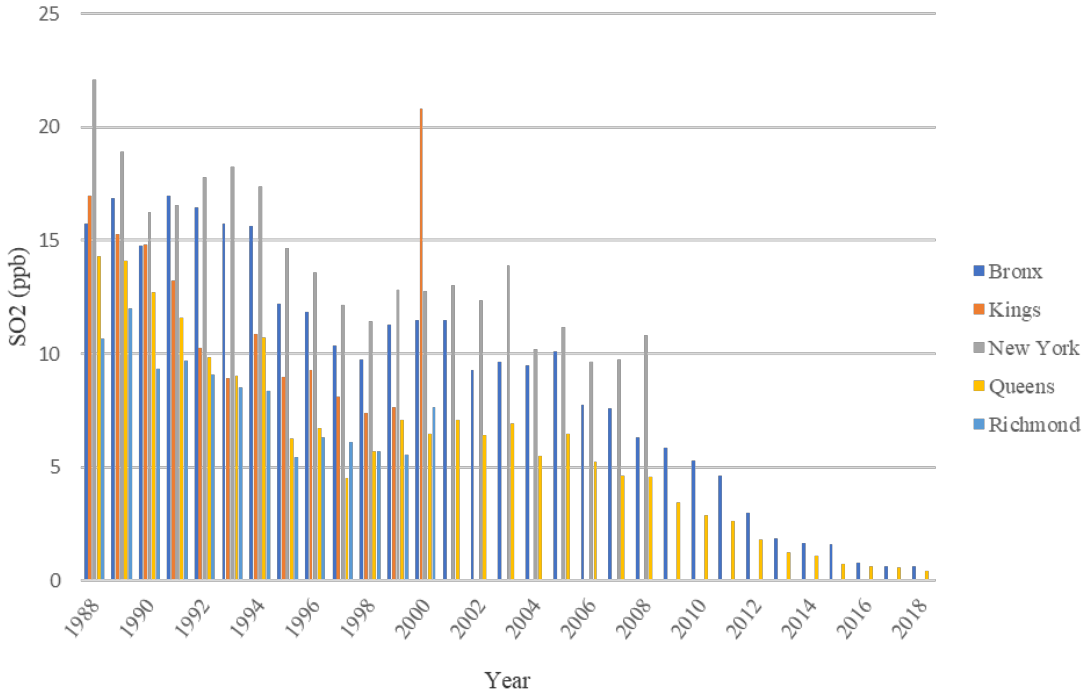


Figure C4- Average annual PM2.5 concentrations by county, 1988-2018

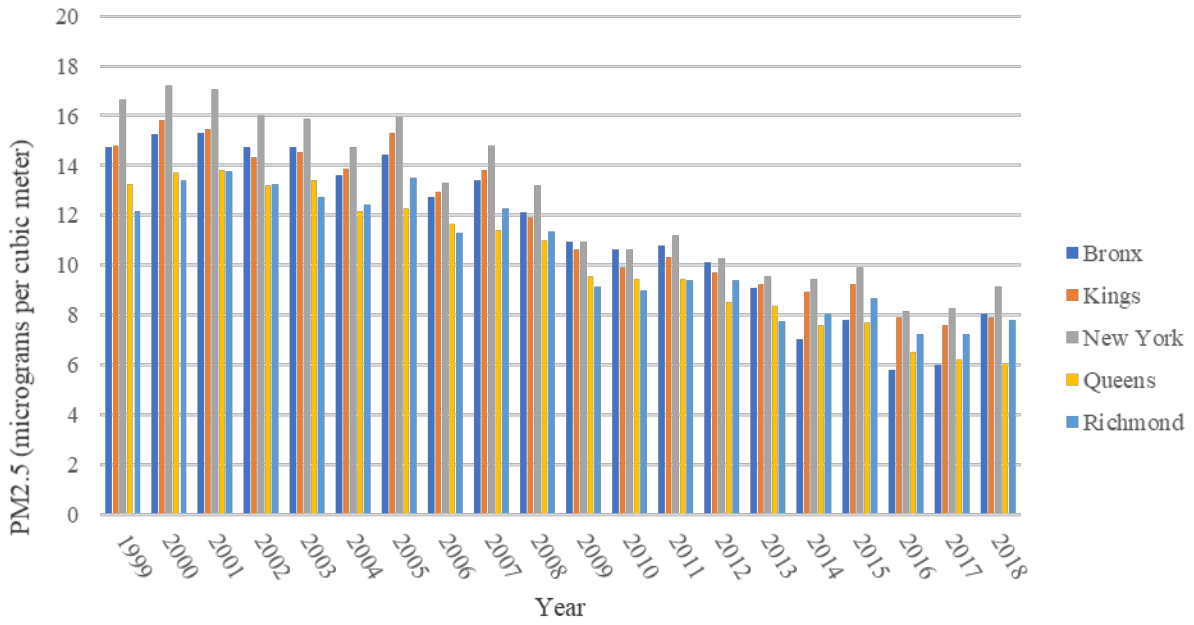


Figure C5- Average annual Ozone concentrations by county: Not within ozone season, 1988-2018

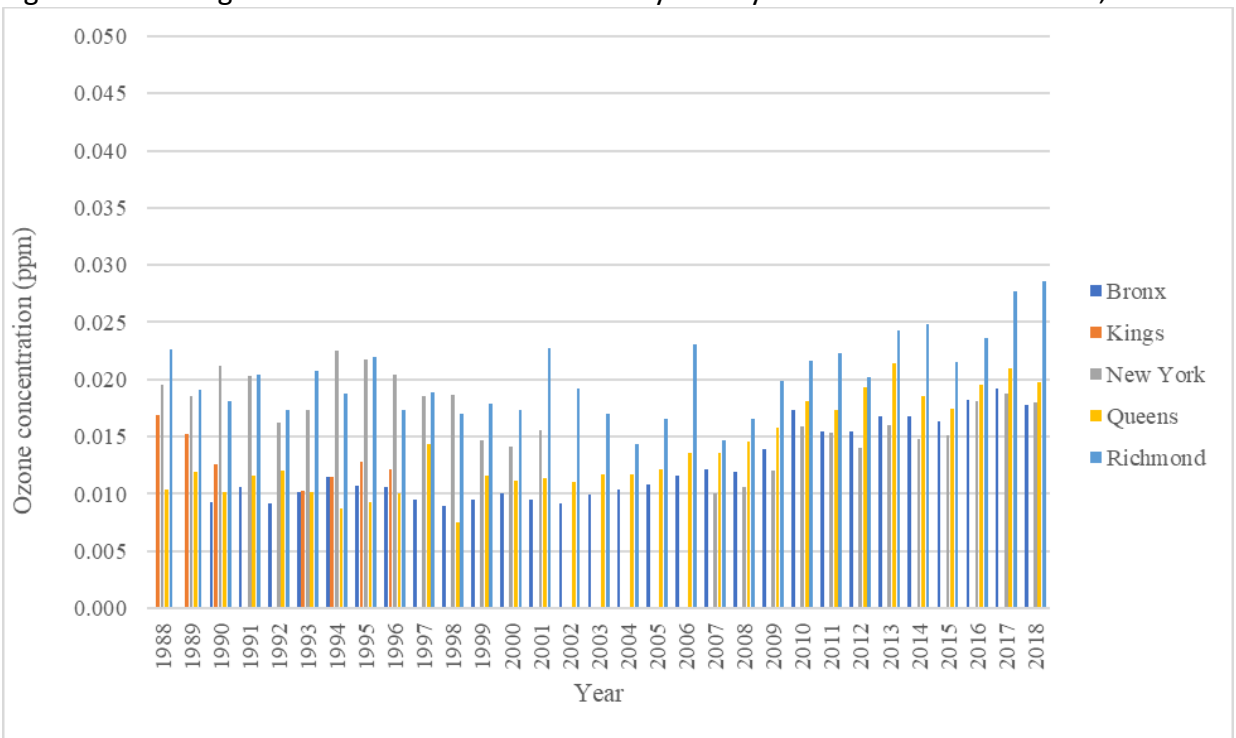
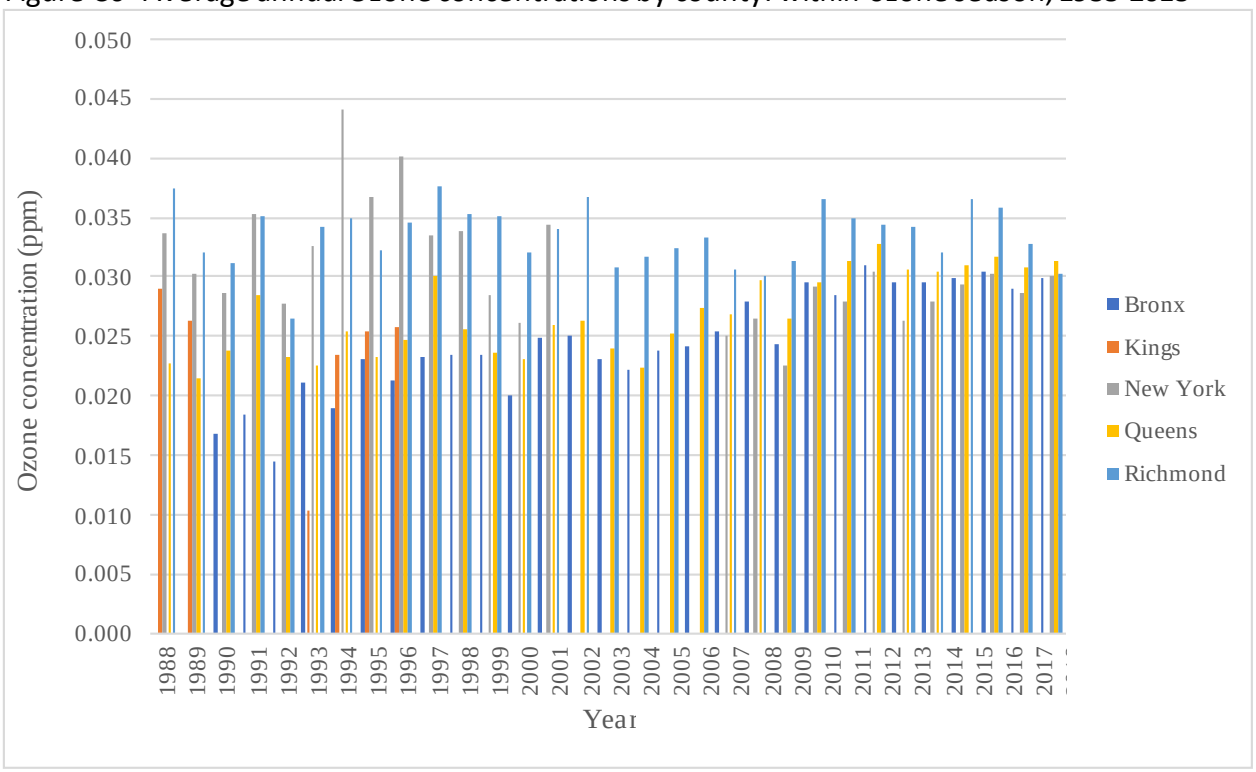


Figure C6- Average annual Ozone concentrations by county: within ozone season, 1988-2018



Appendix D – Maps for select facility categories representing of types of businesses where emissions could potentially be associated with respiratory effects

(Data Source: **2019 communication with NYS DEC Division of Air)**

Figure D1 – Number of Autobody shops per square mile, by UHF-42 neighborhoods in NYC

Figure D2 – Number of wood finishing facilities per square mile, by UHF-42 neighborhoods

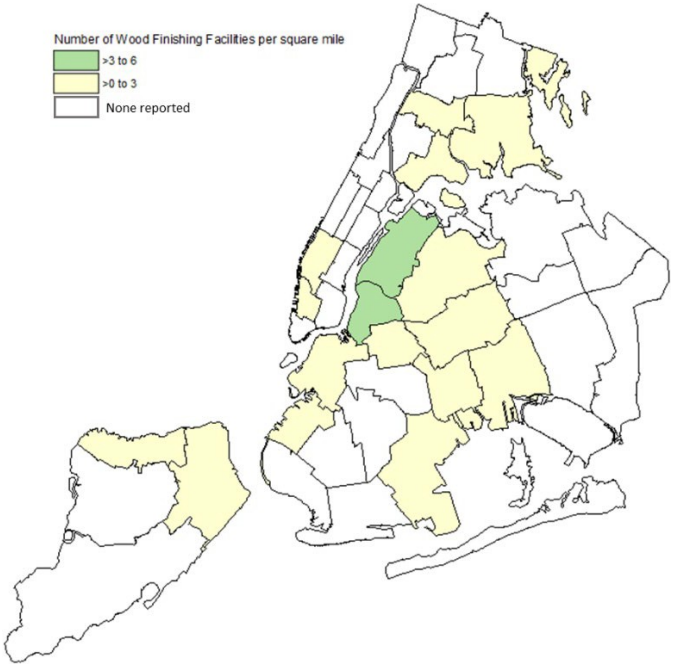


Figure D3 – Number of facilities using isocyanates per square mile, by UHF-42 neighborhoods

Figure D4 – Number of facilities using xylene per square mile, by UHF-42 neighborhoods

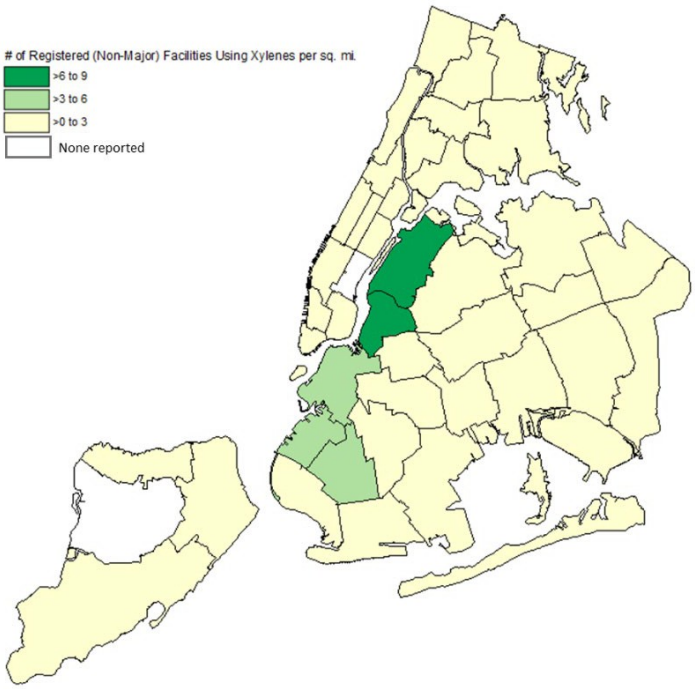
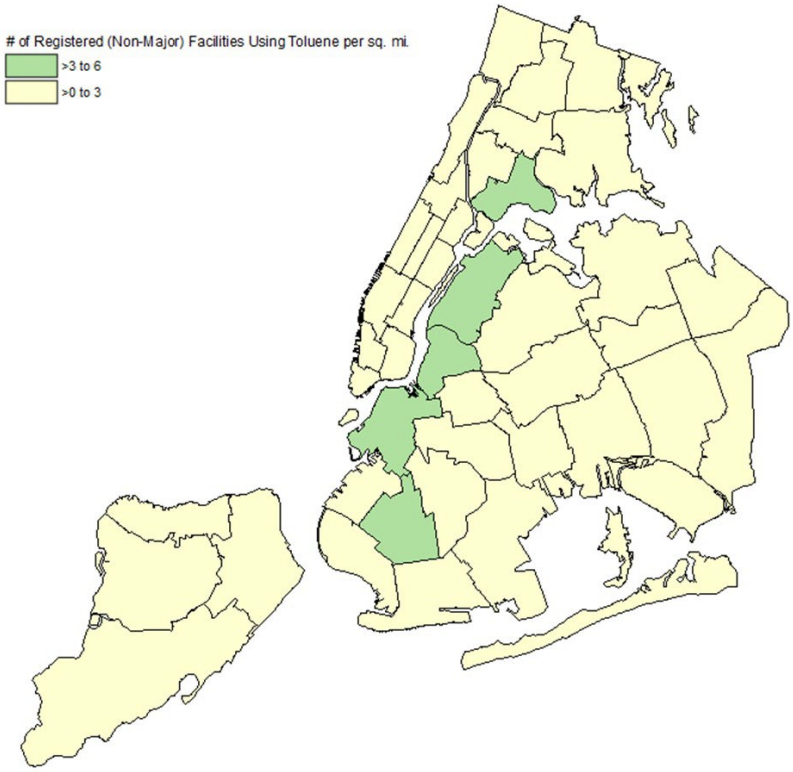
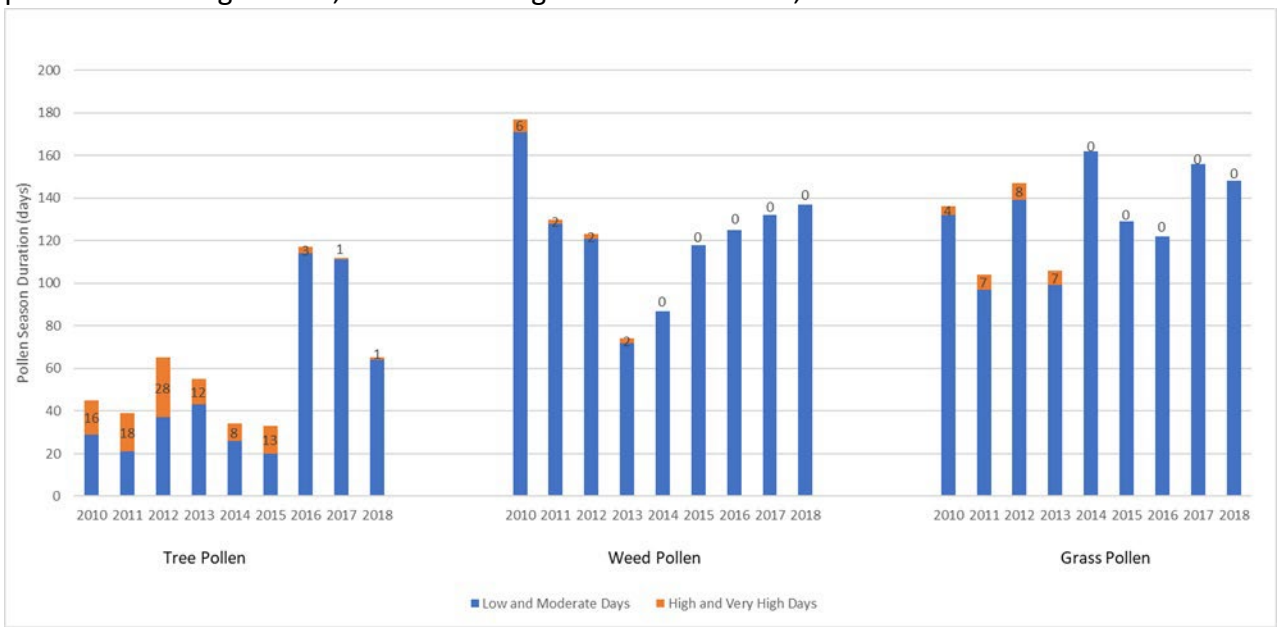


Figure D5 – Number of facilities using toluene per square mile, by UHF-42 neighborhoods



Appendix E – Additional summary of pollen data

Figure E1. Number of pollen season days classified as high-very high* by species and year, at NAB pollen monitoring station, Fordham College at Lincoln Center, 2010-2018**



* Daily pollen concentrations were classified as absent, low, moderate, high, or very high based on NAB classifications

Figure E2. Total Monthly Pollen counts by Pollen Type, Fordham College at Lincoln Center, Manhattan NY, 2010-2018