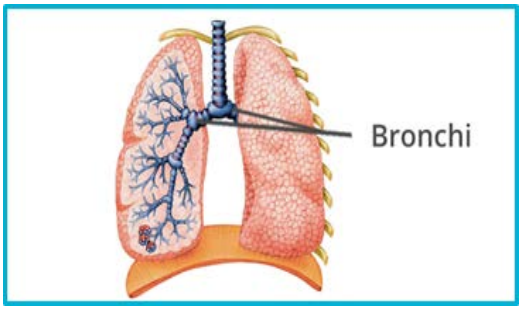
Asthma and Air Quality

Health Department

What we know about asthma

Asthma is labored breathing resulting from spasm of the two major air passages from the windpipe to the lung. Each is called a bronchus (the plural is bronchi). Asthma is episodic, which means that certain triggers cause this bronchospasm, and removal of these triggers usually resolves the problem. Between episodes, the person with asthma usually feels and appears normal. During an episode, or asthma attack, the person experiences "tightness" in the chest and shortness of breath, wheezes and coughs, and may feel anxious and frightened. As a person recovers from the attack, he or she may cough up excess mucus that formed during the attack.

Asthma diagnosis is not made based on patient history. Asthma is diagnosed by a test that measures airway obstruction (called spirometry) and by relief from symptoms following the use of a bronchodilator which opens the airways. Asthma can be addressed in several ways. During an attack, removal of the stimulus causing the attack reverses the bronchospasm. Avoiding the stimulus can prevent an attack altogether. Several types of bronchodilators and anti-inflammatory drugs can also be used to relieve and prevent symptoms.



Asthma triggers

People with asthma experience an asthma attack or episode when they encounter triggers that cause the spasm in the bronchi. There are two basic categories of asthma triggers – those that **inflame** the air passages and those that **irritate** the air passages. Many people who experience asthma attacks react to irritants. Irritants can damage anyone's respiratory tissue. Only people with a specific allergy react to inflammatory triggers.

An inflammatory trigger causes a person's immune system to release histamines and activate T lymphocytes, a certain type of white blood cell. Examples of inflammatory triggers are cockroaches, household dust, mold, and animal dander.

An irritant trigger damages the tissues in a person's airway in a way similar to a burn, with damage to surface cells and swelling below the surface. Examples of irritant triggers include cigarette smoke, exercise, cold air, stress, and air pollutants.

People who are sensitive to inflammatory triggers have a more sensitive system because of this inflammation, and they are likely to be more susceptible to irritant triggers as well.

Asthma in Minneapolis

Asthma is not a reportable disease, so there are no official statistics on the rate of asthma in Minneapolis. Survey estimates are unreliable. Data on asthma-related hospitalizations are available from the Minnesota Hospital Association. While hospitalizations represent only the more severe end of the asthma spectrum, they can be helpful for examining changes over time or differences among different age groups or locations.

Generally, asthma-related hospitalizations have decreased in Minneapolis over the past decade. This decrease may reflect better management of the illness over this period rather than a decrease in incidence, however. The highest number of asthma-related hospitalizations since 2003 was in 2007 and the lowest was in 2013. Numbers for different age groups are shown in Table 1 below.

Table 1: Number of asthma-related hospitalizations in Minneapolis by age group											
Age Group	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
0 - 4 years	154	163	112	148	192	132	133	93	92	101	84
5 -14 years	127	113	84	92	123	91	99	84	82	123	85
15-34 years	125	115	90	88	86	92	99	85	61	72	77
35-64 years	277	286	272	298	302	325	268	289	255	243	244
65+ years	73	77	99	95	88	96	83	65	84	60	86
TOTAL	756	754	657	721	791	736	682	616	574	599	576

Numbers for age groups are not directly comparable because groups range from a 5-year age range to a 30-year age range. Since asthma is not clinically diagnosed until age 6 because the symptoms mimic other illnesses, hospitalizations for children this age may be related to wheezing or respiratory distress associated with another cause.

Indicators of disparities in asthma rates

To compare asthma-related rates by area, a technique known as age-adjustment is used. Because hospitalization rates vary considerably by age, this technique takes those variations into account by calculating the adjusted rate as though each area to be compared had similar proportions of residents in each age group. A five-year period is used for geographic comparisons to minimize minor year-to-year variations.

Area rates are calculated as the number of hospitalizations per 10,000 residents. The six zip code areas with the highest age-adjusted asthma-related hospitalization rates in Minnesota by zip code are all in Minneapolis. The highest rate (43 per 10,000) is in zip code 55411 on the north side. The second highest rate (41 per 10,000) is in zip code 55454 by the University of Minnesota. The next cluster (with rates between 32 and 30 per 10,000 residents) include 55404, 55412 (also on the north side), 55403 and 55414.

A comparison of North Minneapolis zip code rates (43 for 54111 and 31 for 55412) with the Minneapolis-Saint Paul Metropolitan Area as a whole (9) and with the State of Minnesota (7) reveals how disparate these rates are. The 54111 zip code area rate is almost 5 times higher than the rate for the metro area as a whole and 6 times higher than the statewide rate.

Different types of asthma

There are two different types of asthma and these types are affected differently by outdoor and indoor air. Both types involve an inflammatory or irritant trigger, increased reactivity of the bronchi, and inflammation resulting from either an allergic reaction or damage by an irritant. People with either type experience similar symptoms and receive similar treatments and interventions.

Atopic asthma is the most common type of asthma and is the result of a person's immunologic response, which is more commonly called an allergic reaction. Atopic asthma begins in childhood and may accompany other symptoms like a runny nose or eczema. The triggering agent is usually a common environmental antigen, such as pollen, house dust (especially cockroach droppings and animal dander), and certain foods (e.g. milk). People with atopic asthma react to inflammatory triggers and irritant triggers.

Nonatopic asthma involves reactions of the bronchi to irritants that do not trigger an immunologic or allergic response. Common triggers include cigarette smoke, stress, exercise, cold, and viral infection. People with nonatopic asthma react to irritant triggers only.

For example, if a child with atopic asthma encounters cigarette smoke and mold, the child is at increased risk for an asthma attack triggered by the cigarette smoke, in addition to an asthma attack triggered by an allergy to mold. A child with nonatopic asthma may experience an asthma attack triggered by the cigarette smoke, but not an asthma attack triggered by mold. A child without either kind of asthma will not experience an asthma attack triggered by the cigarette smoke or mold.

Indoor air quality refers to the air inside buildings, which may be polluted by cigarette smoking, dust, mites, mold, radon, and other gases and chemicals from materials inside the building. Outdoor air quality refers to pollution caused by particulates, biological molecules, or other harmful materials found outside. Particulate matter is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. Inflammatory triggers and irritant triggers are found both indoors and outdoors.

Indoor air quality

Urban areas tend to have persistently high rates of asthma among children, especially black and Hispanic children. This is based on the number of asthma-related hospitalizations in a community. Studies from the past 15 years report factors associated with an increased risk of asthma. Environmental exposures and other factors examined included allergens in the home from molds, dust mites, cockroaches, mice, cats, and dogs; second hand cigarette smoke; air pollution from industries and traffic stress from poverty and violence; and poor diet, limited physical exercise, and obesity.

The presence or absence of these allergenic triggers affects indoor air quality. Cockroaches are one of the most common asthma-related allergens for children. Mice and mold are far more common that cockroaches in the northern climate of Minneapolis, however, and are a more significant area of concern locally. The most commonly identified asthma triggers in Minneapolis homes are pets, smoking, and cleanliness-related allergens.

The only authority that the Minneapolis Health Department has to become officially involved in indoor air quality questions is through rental housing inspections. Housing inspectors may respond to tenant complaints or conduct routine inspections related to rental licensure. The housing inspectors then enter rental properties, with the tenant's permission, and write housing orders. Table 2 shows the number of housing orders issued in 2014 by the City of Minneapolis related to indoor air quality. In 2014, rental properties in wards 9, 5, and 6 together accounted for almost 45% of the city-wide orders relating to indoor air quality and asthma triggers.

Table 2: Housing orders issued on indoor air quality indicators, 2014

Ward	Count of indoor air quality-related violations in 2014	Percentage of all orders issued on rental properties
09	106	19%
05	71	13%
06	64	12%
08	50	9%
04	48	9%
01	46	8%
10	43	8%
12	30	5%
02	27	5%
07	21	4%
03	17	3%
11	13	2%
13	7	1%
Minneapolis	550	

Indoor air quality interventions

Because of the clear and strong link between indoor air quality and asthma triggers in children, the Minneapolis Health Department partnered in a study on an in-home intervention designed to reduce the burden this condition places on the child and the child's family. The study looked at whether in-home support could assist families in reversing asthma attacks and reducing the number of times doctor's care or missed time from school was needed, as well as reducing the burden that symptoms had on the children. This in-home intervention provided families with products including a High-efficiency particulate arrestance (HEPA) vacuum cleaner, HEPA air cleaner, bed encasements for the child's pillow and mattress, and carbon monoxide and/or smoke detectors. In some cases, structural modifications were offered, including, installation of venting fans, sheet rock removal/disposal, caulking, minor plumbing repairs, and carpeting removal/disposal.

The conclusion of the study was that it was possible to get the desired level of benefit by focusing interventions in the child's bedroom, instead of throughout the house. The study enrolled 294 children with asthma who were referred by physicians, school nurses, other providers, or self-referred. In this case, the desired level of benefit included a significant reduction in hospital admissions for asthma (down 49 visits across the group of 294), emergency department visits for asthma (down 71 visits across the group of 294), outpatient office visits for asthma (down 143 visits across the group of 294), number of school days missed (down 5 days per child), and reduction in daytime and nighttime symptoms, and functional limitations. The modifications were considered sustainable as there were few reports of non-use of the provided products and no reports of the products missing.

Physicians and participants believed that this in-home intervention provides an essential service to low-income children with asthma and their families, and that the in-home products to help control/reverse the asthma would not be available otherwise. Extra teaching and support to manage the child's asthma was also considered important. Table 3 below summarizes some of the findings from the study.

Table 3: Indoor air quality intervention study results, 2010

Patient-centered outcomes	Event reduction within the intervention group (n=294)	Cost of each event	Cost savings (event reduction x cost of each event)
Hospital admissions	down 49 visits	$8,490 per visit	$416,101 per year
Emergency room visits	down 71 visits	$945 per visit	$67,095 per year
Outpatient office visits	down 143 visits	$192 per visit	$27,456 per year

Based on the evidence provided by this study, legislation is currently being introduced at the state level to make a visit by a Healthy Homes practitioner and an asthma educator visit reimbursable by Medicaid. This visit includes guidance on removal or reduction in asthma triggers and provision of products designed to assist the household with following the recommendations.

Outdoor air quality

According to the EPA, research by the agency and others suggests that ozone and particle pollution can cause asthma attacks. When ozone levels are high, on a day with poor air quality, more people have asthma attacks that need a doctor's attention. Ozone also makes people with atopic asthma more sensitive to inflammatory triggers, such as pet dander, pollen, dust mites, and mold.

People with atopic asthma have an internal immunological response that can react to irritants, such as those present in ozone, in addition to their other inflammatory triggers. On days with high levels of ozone, people with nonatopic asthma can have a reaction when damage to respiratory tissue occurs after inhalation of the irritant. Table 4 shows trends for the percentage of days when the levels of Twin Cities ozone was of concern, especially for sensitive groups, such as people with atopic asthma or other respiratory conditions, like chronic obstructive pulmonary disease, chronic bronchitis, and breathing difficulties, or people with heart problems. The health value used is the National Ambient Air Quality Standard (NAAQS).

Table 4: Percentage of days exceeding the ozone concentration health value in the Twin Cities, 2003 - 2013

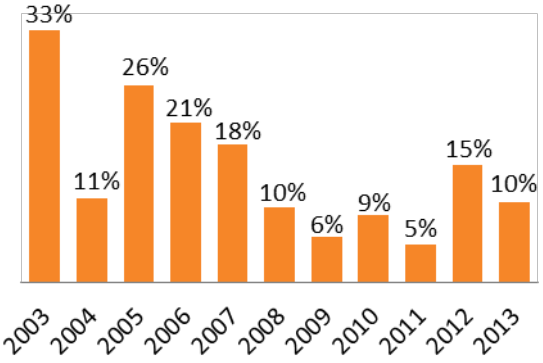
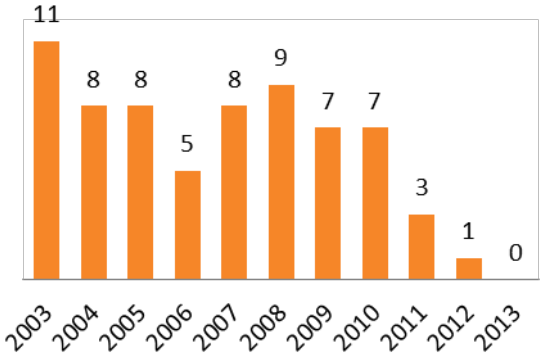


Table 5: Minneapolis daily average fine particle concentration (PM2.5) counts, 2003 - 2013



Ground level ozone is created by chemical reactions between oxides of nitrogen (NOx) and Volatile Organic Compounds (VOCs) that occur in the sunlight. Children are considered to be at the greatest risk from exposure to ground level ozone not only because their lungs are still developing, but because they are more likely to be active outdoors when ozone levels are high. Because ozone is an irritant, it can both activate atopic asthma and cause a nonatopic asthma episode through irritation of the lining of the respiratory system. This is reflected by increases in asthma-related hospitalizations and emergency department visits during the EPA-defined Minnesota ozone season, which is annually April 1 – September 30.

High levels of air pollution (ozone, nitrogen oxides, acidic aerosols, and fine particles) are associated with worsened asthma symptoms. These pollutants come from smoke, dust, and emissions from cars, factories, and power plants. Diesel exhaust promotes asthma attacks as both an irritant trigger and worsening inflammation and damage in someone with atopic asthma, leaving them more susceptible to inflammatory triggers.

Exposure to traffic and fine particle concentration can override protective effects of high lung function and increase rates of asthma attacks. Particulate matter can increase airway hyperactivity, and exacerbate atopic asthma or nonatopic asthma. Table 5 shows trends in the number of days when fine particle concentrations (particle matter 2.5 micrometers or less in size) were unhealthy for sensitive groups.

Outdoor air quality interventions

The Minneapolis Health Department is currently doing an air quality study looking at Volatile Organic Compounds (VOC) emissions across the city. The study is centered on health risk values, or the amount of each VOC that is associated with an increased risk for negative health effects. The goal is to better understand the relationship between things we measure in the air, sources of pollution, and health effects. This will help the Minneapolis Health Department make specific recommendations about environmental changes that the city can make to improve the health of vulnerable populations. These recommendations will work with current Minneapolis Health Department initiatives and interventions. This study is part of a broader Minneapolis Health Department strategy to relate data on ozone, particulates, PM2.5, and VOCs with health effects and health outcomes.

There are actions that the city has taken already, based on what we know reduces irritants to the lining of anyone's respiratory systems. Project Green Fleet has provided support to retrofit all of the city's diesel vehicles to reduce diesel emissions between 30 – 90 percent, including school buses and fire trucks. Minneapolis is the first city in the nation to retrofit fire trucks, and Minnesota is the first state to retrofit all school buses. City vehicles are also required to follow an idle-reduction strategy to ensure that no City-used vehicle idles for more than five minutes.

The Minneapolis Health Department uses Green Business Matching grants to offer support for dry cleaners, auto body shops, or other businesses moving away from processes that create VOC emissions. This helps keep our business community strong, and clearly changes VOC emissions, reducing one of the two ingredients of ground level ozone. The Cool Soils partnership between the City of Minneapolis and the Shakopee Mdewakanton Sioux community is studying adding Biochar to compost to increase the effectiveness of both materials. Biochar is a soil additive which is being studied for its effectiveness in making plants and trees more drought tolerant, increasing growth rates, sequestering carbon, and restoring urban soil health.

The Urban Forestry Project by the Minneapolis Health Department connects businesses and non-profit organizations with free trees to be planted on their property, with the condition that the organization then water and care for the tree. This effort is designed to mitigate the health effects of pollution by planting trees that absorb pollutants like ozone, nitrogen dioxide, and sulfur dioxide through the leaves, intercepting particle matter like dust, ash, and smoke, releasing oxygen through photosynthesis, and lowering air temperatures overall, reducing the production of ozone. Minneapolis is unique in this effort because of a major gap in the urban tree canopy that the Minneapolis Health Department identified as the level of coverage for commercial properties. In addition to this distinct approach, Minneapolis Health Department offers education to residents on which species of trees improve air quality, while other organizations make trees available to private property owners.

Conclusion

Asthma and air quality in Minneapolis is a social and environmental justice issue, and will take a combination of strategies aimed at achieving health equity for all residents and visitors. Achieving health equity requires coordinated efforts to address the social determinants of population health. This means engaging many partners in the public and private sectors. While the Minneapolis Health Department is capable and experienced in convening others, developing plans for action, and in some cases, regulating code, other agencies in local government often have primary responsibility for overseeing and impacting a number of air quality and asthma-related determinants. As a local health department, we are well positioned to help leverage the influence of our fellow city departments and other municipal and state partners. We will continue to align our efforts and create innovative solutions so that systems and opportunities are increasingly more equitable. Our standard is the health of all Minneapolis residents, and we will continue to hold ourselves to that standard as we lead the nation in air quality improvement and asthma reduction efforts.

For a copy of this report, please visit the Minneapolis Health Department website:
http://www.minneapolismn.gov/health/reports/asthma.pdf

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