
Asthma Burden Report New Hampshire 2010-2012

Chapter 5: Asthma and the Environment



Preface

In order to provide data in a timely manner, the New Hampshire Asthma Control Program will publish chapters of the *Asthma Burden Report – New Hampshire 2010-2012* as they are completed. The primary purpose of this report is to disseminate data to the Asthma Control Program’s partners, health care providers, insurers and public health professionals so this information can be used to develop, plan, implement and evaluate asthma-related activities.

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Asthma and the Environment

Highlights

- The prevalence of daily asthma symptoms among non-smoking adults with asthma reporting someone had smoked in their home recently (32 percent) was twice that of adults with asthma not reporting smoking in the home (16 percent) (2009 NH BRFSS).
- Forty-eight percent of adults with current asthma and 46 percent of children* with current asthma reported ever being advised by a health professional to make changes in their home, school or work environment to improve their asthma (2006–2010 ACBS).
- Seven percent of New Hampshire adults with current asthma reported ever being told by a health professional that their asthma was work-related. However of those never diagnosed with work-related asthma, 37 percent reported they think their asthma was caused or aggravated by a current or former job (2006–2010 ACBS).
- Only 37 percent of NH school principals reported their school had a school improvement plan that included a healthy and safe school environment (2010 NH School Health Profile).
- Sixty-seven percent of adults with current asthma reported they were aware of the Air Quality Index or New Hampshire’s Air Quality Action Days (2007 NH BRFSS).
- The proportion of NH adults with asthma who were aware of the Air Quality Index or Air Quality Action Days was significantly higher among those with higher incomes, higher levels of education and older ages, but did not differ by asthma status (2007 NH BRFSS).
- The proportion of adults with current asthma reporting they had reduced their activity levels due to awareness of poor air quality was more than three times higher among those advised by a health professional to make these changes (60 percent) compared to those not reporting advice by a health professional (19 percent) (2007 NH BRFSS).

*Results for children were based on the report of a knowledgeable adult in their household.

Introduction

The National Heart Lung and Blood Institute Expert Panel Report 3 (NHLBI EPR3) found that “for successful long-term management of asthma, it is essential to identify and reduce exposures to relevant allergens and irritants. Reduction of exposure can be accomplished by making environmental changes or avoiding conditions that cannot be controlled.”¹

Environmental components that can make asthma worse include:

- Allergens such as dust mites, dander and hair from pets and pests such as mice and cockroaches, seasonal pollen, and mold.
- Irritants such as smoke from tobacco, cooking and heating fuels; chemicals from cleaning or construction materials (including paint, formaldehyde and volatile organic compounds); components of outdoor air pollution, and cold air.

Home Environment

Most people spend large portions of time in their homes, a common source of many asthma triggers, including particulates from tobacco smoke and heating and cooking fuels; allergens from mold, hair and dander from pets; and dust mites and other household pests.

Asthma triggers in the home

The Behavioral Risk Factor Surveillance System (BRFSS)² Asthma Callback Survey (ACBS)³ asked New Hampshire adults with current asthma and adults reporting on children with current asthma about environmental modifications in their homes that can improve asthma symptoms and prevent asthma exacerbations.

The asthma trigger most frequently reported by both adults with current asthma and adults with children having current asthma, was carpeting or rugs in the bedroom, while the least prevalent was use of an unvented gas appliance in the home (Figure 1 and Table 1).

Figure 1
NH adults and children with current asthma who reported the indicated asthma triggers in their homes, ACBS**

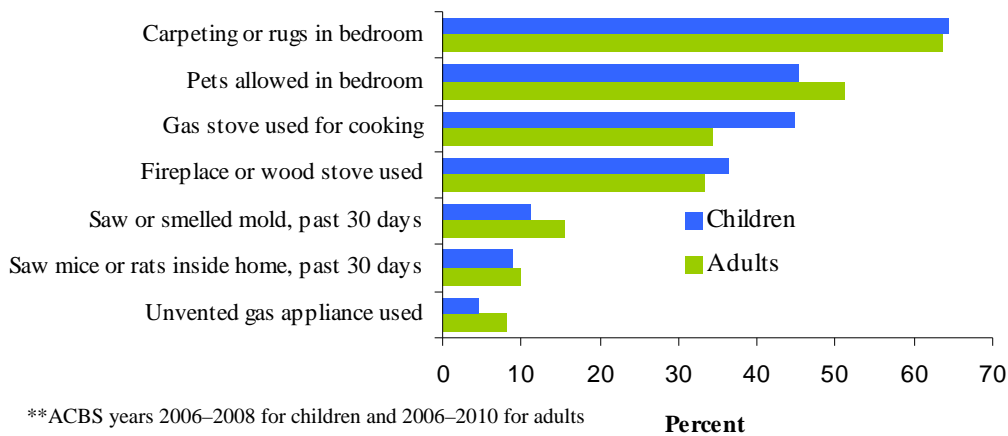


Table 1

Asthma trigger	Children with current asthma, ACBS 2006 - 2008		Adults with current asthma, ACBS 2006 - 2010	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval
Carpeting or rugs in bedroom	64.5	56.3 - 72.8	63.6	59.8 - 67.4
Pets allowed in bedroom	45.3	35.8 - 54.7	51.1	47.2 - 55.0
Gas stove used for cooking	44.9	35.8 - 53.9	34.3	30.6 - 38.0
Fireplace or wood stove used	36.5	27.5 - 45.5	33.3	29.6 - 37.1
Saw or smelled mold, past 30 days	11.2	4.8 - 17.6	15.4	12.6 - 18.2
Saw mice or rats inside home, past 30 days	8.8	3.5 - 14.2	9.9	7.5 - 12.3
Unvented gas appliance used	4.7	0.7 - 8.7	8.2	5.9 - 10.5

The NHLBI EPR3 recommends that clinicians ask patients about factors in their environment, including asking patients about their smoking status, and consider specifically referring to smoking cessation programs adults who smoke and have young children who have asthma in the household. In addition, smokers with asthma or with children who have asthma should ask family members to quit smoking, not allow smoking in their home or car, and be sure no one smokes at the child’s daycare center or school.

Particulates from tobacco smoke are not just present when someone is actively smoking. Combustion products persist on furniture, carpets, and other household items after smoking has stopped. Households should make and enforce rules for the household prohibiting smoking inside the home or automobiles. Parents should be sure no one in their child’s daycare facility smokes.¹

Eleven percent of New Hampshire children with current asthma lived in homes where someone had smoked inside the home in the previous week (95% CI: 5.0–16.8) (2006–2008 ACBS). The number of respondents reporting on children with asthma was too small for analysis by demographic characteristics or asthma symptoms.

In 2009, 6.3 percent of non-smoking adults with current asthma lived in homes where someone had smoked inside in the past week, while 49.9 percent of current smokers with asthma reported someone had smoked inside of their home (Table 2). The proportion of New Hampshire adults reporting someone had smoked inside of their home in the past week did not differ significantly by current asthma status for either non-smokers or current smokers (Table 2).

No statistically significant difference was found in the proportion of non-smoking New Hampshire adults reporting someone had smoked inside one or more of their private autos in the past

Table 2

NH adults reporting someone smoked inside of their home in the past week, by current smoking and current asthma status, 2009 NH BRFSS

Smoking status	<i>Current asthma</i>		<i>No current asthma</i>	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval
Current smoker	49.9	36.3 - 63.5	42.8	37.0 - 48.6
Non-smoker	6.3	3.3 - 9.3	4.1	3.1 - 5.1

week by current asthma status (Table 3). There was also no significant difference by asthma status among current smokers (Table 3).

Table 3

NH adults reporting someone smoked inside of their auto in the past week, by current smoking and current asthma status, 2010 NH BRFSS

Smoking status	<i>Current asthma status</i>		<i>No current asthma</i>	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval
Current smoker	49.9	36.6 - 63.3	39.9	34.7 - 45.1
Non-Smoker	5.0	2.7 - 7.2	6.0	5.0 - 7.0

A significantly higher proportion of adult non-smokers reporting someone had smoked in the home in the past week also reported one or more urgent visits to their health care provider in the past year (Chi Square P value = 0.01)* (Table 4). The proportion if non-smokers reporting Emergency Department (ED) visits and inpatient stays did not differ significantly by indoor smoking status (Table 4).

Table 4

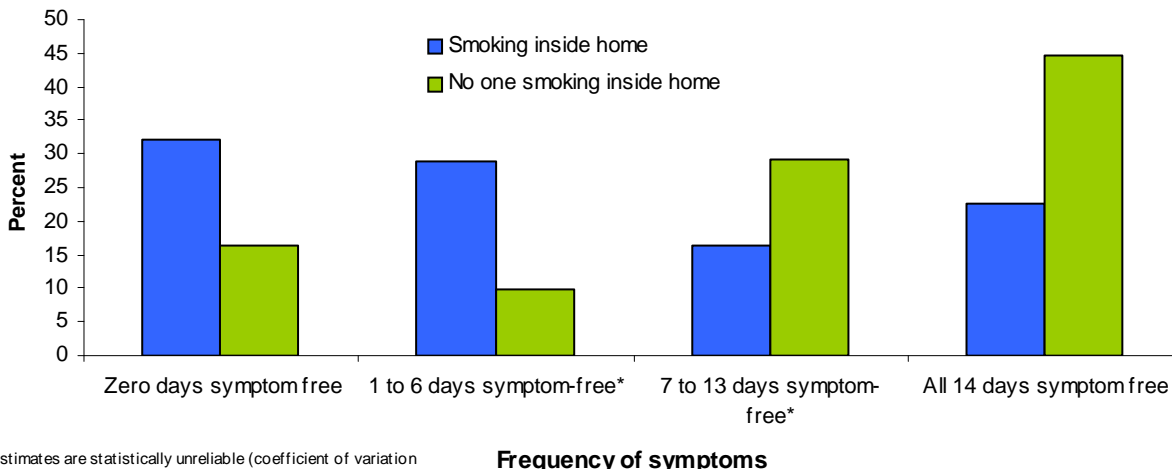
NH adult non-smokers with current asthma reporting the indicated types of health care utilization by whether someone had smoked in the home recently, 2006–2010 ACBS						
<i>Type of care</i>	<i>One or more urgent visits</i>		<i>One or more ED visits</i>		<i>One or more hospital stays</i>	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval	Percent	95% Confidence Interval
Home smoking status						
Smoking in the home	36.5	17.1 - 56.0	11.2	3.0 - 19.5	1.7	0.0 - 4.3
No smoking in home	16.7	13.8 - 19.6	8.3	6.3 - 10.2	2.5	1.4 - 3.5

Among non-smoking New Hampshire adults with current asthma, the percentage reporting being symptom-free on all of the previous 14 days was significantly higher among those reporting there was no recent smoking inside their home (44.5%) compared with those reporting recent smoking inside the home (22.6%) (Figure 2, Table 5).

*Unless otherwise noted, estimates in this report are “statistically significant” when the 95% confidence intervals do not overlap. Sometimes, if confidence intervals do overlap, estimates may still be statistically significant and additional tests, such as a Chi Square test, can be performed to further check significance. The Chi Square P value is the probability that estimates are truly different. A P value of 0.05 or less indicates 95% confidence that the estimates differ. For additional information, see Appendix B, Technical Notes and Methods at: www.dhhs.nh.gov/dphs/cdpc/asthma/documents/appendixb.pdf.

Figure 2

Percentage of NH adult non-smokers with current asthma reporting the number of symptom-free days they experienced in the past 2 weeks, by whether smoking in the home was reported, 2006-2010 ACBS



*Estimates are statistically unreliable (coefficient of variation greater than 30%).

Table 5

Percentage of NH adult non-smokers with current asthma reporting the number of symptom-free days they experienced in the past 2 weeks, by whether smoking in the home was reported, 2006-2010 ACBS

Number of days free of asthma symptoms in past 14 days	Reported someone smoked inside the home		Reported no one smoked inside the home	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval
Symptoms every day	32.0	15.9 - 48.2	16.4	13.6 - 19.2
1 to 6 days symptom-free	28.9*	8.7 - 49.2	9.9*	7.8 - 12.1
7 to 13 days symptom-free	16.4*	0.4 - 32.4	29.2*	25.1 - 33.3
No days with symptoms	22.6	9.1 - 36.1	44.5	40.1 - 48.9

Home Modifications to improve asthma

The ACBS asked New Hampshire adults with current asthma and adults reporting on children with current asthma about environmental modifications in their homes that can improve asthma symptoms and prevent asthma exacerbations.

The most frequently reported modification among both adults and children with current asthma was an exhaust fan used in the bathroom. The least commonly reported modification among adults with current asthma was use of both mattress and pillow covers; the least commonly reported for children with asthma was use of an air cleaner (Figure 3, Table 6). Note that the NHLBI EPR3 reports that the evidence for the effectiveness of air cleaners is not strong enough to recommend their use and that air cleaners that work by generating ozone should be avoided by people with asthma.¹

Figure 3

NH adults and children with current asthma reporting home modifications that can control asthma triggers, 2006 -2010 ACBS

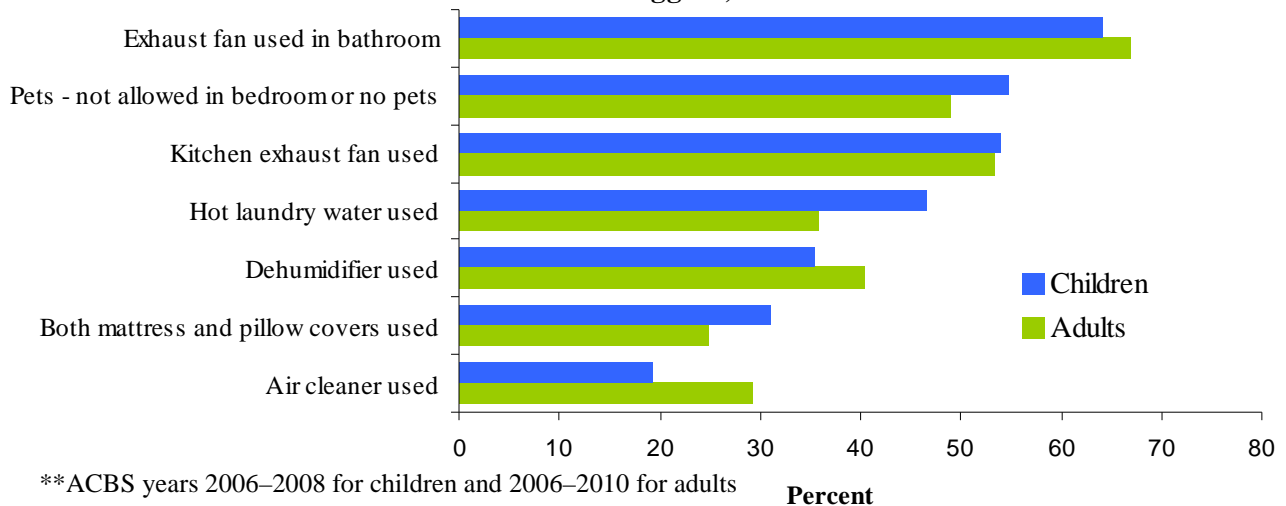


Table 6

NH adults and children with current asthma reporting home modifications that can control asthma triggers, ACBS

Modification	Children with current asthma ACBS, 2006–2008		Adults with current asthma, ACBS 2006–2010	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval
Exhaust fan used in bathroom	64.0	55.5 - 72.5	66.9	63.2 - 70.5
Pets - not allowed in bedroom or no pets	54.7	45.3 - 64.2	48.9	45 - 52.8
Kitchen exhaust fan used	54.0	44.9 - 63	53.3	49.4 - 57.3
Hot laundry water used	46.6	37.6 - 55.7	35.9	32.3 - 39.4
Dehumidifier used	35.4	27.1 - 43.7	40.3	36.4 - 44.2
Both mattress and pillow covers used	31.0	22.8 - 39.2	24.8	21.6 - 28.1
Air cleaner used	19.3	12.4 - 26.3	29.2	25.6 - 32.8

Rules against smoking in the home and car

During 2009, 82 percent of New Hampshire children with current asthma lived in homes with rules against smoking anywhere inside of the home (95% confidence interval: 73.7–89.3) (2009 BRFSS). No significant difference was found for children in the prevalence of no-smoking rules by current asthma status.

Among non-smoking New Hampshire adults with current asthma, 91 percent reported they had rules against smoking anywhere inside their homes and 90 percent reported rules against smoking inside their automobiles. No significant difference was found in the prevalence of no-smoking rules by current asthma status (Table 7).

Table 7

NH adult non-smokers with no-smoking rules in homes and autos, by current asthma status, 2009 and 2010 NH BRFSS				
Smoking rules	<i>Current asthma</i>		<i>No current asthma</i>	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval
Smoking is not allowed anywhere inside home, 2009	91.0	88.0 - 94.0	88.1	86.7 - 89.4
Never allowed in any vehicle, 2010	89.9	86.2 - 93.6	89.1	87.7 - 90.5

No statistically significant differences were found by demographic characteristics in the proportion of non-smoking adults with current asthma reporting no-smoking rules in their homes (Table 8).

Table 8

NH adult non-smokers with current asthma reporting they have rules against smoking anywhere in their home, by demographic characteristics, 2009 NH BRFSS		
Characteristic	Percent	95% Confidence Interval
Total	91.0	88.0 – 94.0
Sex		
Male	90.0	84.9 – 95.0
Female	91.7	87.9 – 95.4
Age		
18 to 44	93.5	88.5 – 98.5
45 to 64	90.3	86.2 – 94.5
65 or older	84.9	77.6 – 92.3
Education		
High school, GED or less	86.6	80.6 – 92.6
Some college, technical school or more	92.6	89.1 – 96.0
Income		
Less than \$50,000	88.7	83.4 - 94.0
\$50,000 or more	93.5	89.4 - 97.5

No statistically significant differences were found by demographic characteristics in the proportion of non-smoking adults with current asthma reporting no-smoking rules in their automobiles (Table 9).

Table 9

Percentage of non-smoking NH adults with current asthma reporting they have rules against smoking in any of their automobiles, by demographic characteristics, 2010 NH BRFSS

Characteristic	Percent	95% Confidence Interval
Total	89.9	96.2 – 93.6
Sex		
Male	89.6	83.4 – 95.8
Female	90.1	85.4 – 94.7
Age		
18 to 44	90.0	83.6 – 96.4
45 to 64	89.4	84.3 – 94.4
65 or older	90.5	84.8 – 96.2
Education		
High School, GED or less	84.7	77.0 – 92.5
Some college, technical school or more	91.9	87.8 – 96.1
Income		
Less than \$50,000	88.0	82.2 - 93.8
\$50,000 or more	92.6	88.2 - 96.9

Medical professional advice to modify environment to improve asthma

The NHLBI EPR3 recommends that medical professionals advise patients with asthma to reduce or avoid exposure to indoor and outdoor allergens and irritants that can make asthma worse. Reduction of exposure to irritants and allergens can improve asthma symptoms and reduce asthma episodes.

The ACBS found that less than half of adults and children with current asthma reported ever being advised by a health professional to change things in their home, school, or work to improve their asthma (Table 10).

Table 10

NH adults and children with current asthma ever advised to make changes in home, school or work to improve asthma, ACBS

	Percent	95% Confidence Interval
Adults with current asthma, 2006-2010	47.7	43.8 - 51.6
Children with current asthma, 2006-2008	46.1	37.4 - 54.7

No significant differences were found by asthma control status in the proportion of adults reporting being advised by a health professional to make environmental changes (Figure 4, Table 11). Adults with asthma that was not well controlled might be expected to have a higher prevalence of provider advice to make environmental modifications. For more information on how asthma control was defined, see the Asthma Burden Report’s Appendix B, Technical Notes and Methods at: www.dhhs.nh.gov/dphs/cdpc/asthma/documents/appendixb.pdf.

Figure 4

NH adults with current asthma reporting they were ever advised to make changes in home, school, or work to improve asthma, by asthma control status, 2006–2010 ACBS

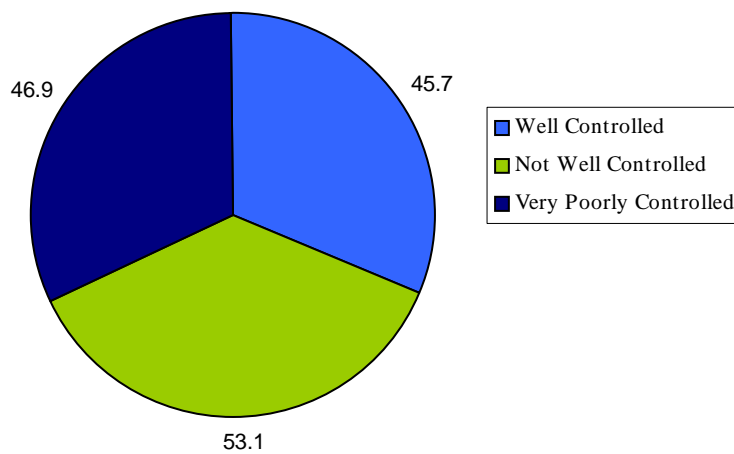


Table 11

NH adults with current asthma reporting they were ever advised to make changes in home, school, or work to improve asthma, by asthma control status, 2006–2010 ACBS

Control level	Percent reporting advice to modify environment	95% Confidence Interval
Well Controlled	45.7	40.1 - 51.2
Not Well	53.1	45.8 - 60.4
Very Poorly	46.9	39.6 - 54.2

The proportion of New Hampshire adults advised to make changes to their environment because of their asthma was significantly higher among women than men, declined significantly as age increased, and was higher among adults with some post-secondary education compared with adults with a high school diploma, GED or less education (P for Chi Square test = 0.02) (Figure 5, Table 12). No significant differences were found by income.

Figure 5

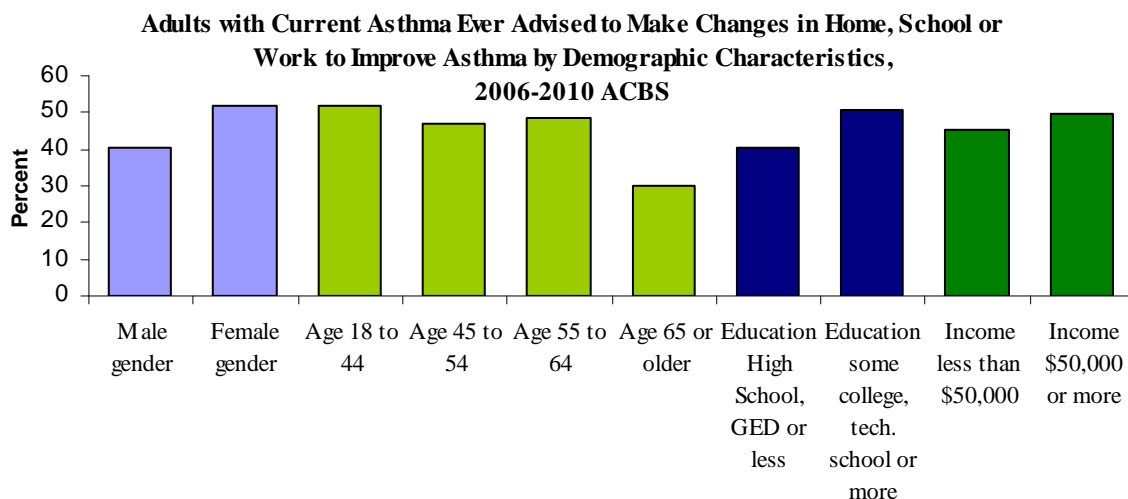


Table 12

NH adults with current asthma ever advised to make changes in home, school or work to improve asthma, by demographic characteristics, 2006 – 2010 ACBS

Characteristic	Percent	95% Confidence Interval
Total	47.7	43.8 – 51.6
Sex		
Male	40.6	33.2 - 48.0
Female	51.6	47.3 - 56.0
Age		
18-44	51.8	45.3 - 58.3
45 to 54	46.8	39.9 - 53.8
55 to 64	48.3	41.8 - 54.7
65+	30.2	23.8 - 36.5
Education		
High School grad, GED or less	40.3	33.2 - 47.4
Some college, tech. school or more	50.5	45.9 - 55.1
Income		
Less than \$50,000	45.3	39.9 - 50.8
\$50,000 or more	49.4	43.7 - 55.1

School Environment

There are approximately 20,000 school-aged children between the ages of five and 17 years in New Hampshire with current asthma (2006–2008 BRFSS). Most spend a minimum of six months of the year in school buildings receiving instruction.⁴

The United States Environmental Protection Agency (EPA) reports that “environmental asthma triggers commonly found in school buildings include respiratory viruses; cockroaches and other pests; mold resulting from excess moisture in the building; dander from animals in the classroom; and dander brought in on clothing from animals at home. Secondhand smoke and dust mites are other known environmental asthma triggers found in schools.”⁵ EPA also reports that children with asthma may be affected by irritants from unvented stoves or heaters and common products including chemicals, cleaning agents, perfumes, pesticides, and sprays.

Although data related to school environments in New Hampshire are limited, a study conducted by the New Hampshire Department of Education (DOE) in 2000 found that 36 percent of New Hampshire schools were built before 1950, 53 percent reported ventilation problems, 33 percent reported a leaking roof, and 29 percent reported air quality problems.⁶

These conditions can expose children to mold, dust, particulates, and other indoor air pollutants and result in worsening of asthma symptoms among children as well as faculty and staff.

A 2010 survey of New Hampshire school health services conducted by the DOE found that 63 percent of nurses reported, on average, that they treated one or more students for asthma every school day⁷ suggesting the problem of asthma exacerbation in schools is a significant burden on both student health and staff time.

The 2010 School Health Profile, a survey of New Hampshire principals and health teachers, found that 86 percent of school principals reported that their school attempts to minimize asthma triggers in the school environment for students with poorly controlled asthma. Sixty-one percent reported that their school follows a policy that mandates no tobacco use by students, staff, or visitors in school buildings, at school functions, on school grounds, in school vehicles, or at off-site school events. However, only 34 percent of principals reported that their school had a school improvement plan that included a healthy and safe school environment.⁸

The EPA's Tools for Schools® (TfS)⁹ program provides tools and guidance for schools wanting to assess and improve their indoor air quality. EPA defined the following technical solutions to the most common problem areas that schools encounter:

Quality HVAC (Heating Ventilation and Air Conditioning)

- Establish an HVAC plan
- Conduct regular inspections and maintenance
- Maintain outdoor air ventilation according to American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards or local codes
- Clear ventilation areas of books, papers, etc

Control of Moisture/Mold

- Maintain indoor humidity between 30 and 60 percent
- Dry wet areas within 24 to 48 hours
- Establish a mold protection and remediation plan
- Inspect routinely

Strong Integrated Pest Management (IPM)

- Establish an IPM plan
- Inspect regularly
- Use spot treatments and baits
- Communicate with occupants prior to pesticide use
- Mark areas treated with pesticides

Effective Cleaning and Maintenance

- Establish a plan
- Conduct routine inspections
- Train cleaning and maintenance staff on protocols
- Make Material Safety Data Sheets (MSDS) available to staff
- Clean and remove dust with damp cloth
- Vacuum using high-efficiency filters

Smart Materials Selection

- Maintain a product inventory
- Develop low-emitting product purchasing and use policies
- Use only formaldehyde-free materials
- Use only low-toxicity and low-emitting paint
- Select products based on product rating systems
- Use the least toxic cleansers possible

Aggressive Source Control

- Conduct regular building walkthrough inspections
- Test for radon and mitigate if necessary
- Develop and implement a hazardous materials plan
- Establish a school chemical management and inventory plan
- Implement smoke-free policies
- Establish an anti-idling school bus policy
- Use walk-off mats at building entrances
- Conduct pollutant-releasing activities when school is unoccupied

Information about Tools for Schools can be found at: <http://epa.gov/iaq/schools/>.

Work Environment

The term work-related asthma (WRA) refers to both new cases of asthma caused by exposures at work, or “new-onset” WRA, and to pre-existing asthma that is made worse by workplace exposures, called “work-aggravated” asthma.^{10,11}

The National Institute for Occupational Safety and Health (NIOSH) defines new-onset WRA as asthma diagnosed following no history of asthma or as preexisting asthma (e.g., childhood asthma) that had been asymptomatic for at least two years before entering the workplace where asthma was diagnosed.¹¹

NIOSH further defines two types of new-onset asthma as:

- “reactive airways dysfunction syndrome (RADS) (i.e., persistent asthma symptoms induced by a one-time, high-level irritant exposure at work); and
- occupational asthma (e.g., classic sensitizer-induced asthma and irritant-induced asthma not meeting the RADS criterion).”

There are more than 350 substances used in the workplace that are known to either cause asthma in healthy workers or aggravate asthma in those who already have the condition.¹² These substances are sometimes referred to as *asthmagens*; exposure to asthmagens causes sensitization of the airways. Asthmagens can be inhaled or pass through the skin. The number of substances attributed to causing or aggravating asthma continues to grow (Table 13).

Table 13

<i>Agent Category</i>	<i>Work-aggravated asthma</i>		<i>Reactive airways dysfunction syndrome</i>		<i>Occupational asthma</i>		<i>Unclassified</i>	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Miscellaneous chemicals	203	4.9	70	1.7	418	10.1	109	2.6
Mineral and inorganic dust	156	3.8	24	0.6	305	7.4	70	1.7
Cleaning materials	123	3.0	80	1.9	237	5.7	41	1.0
Indoor air pollutants	96	2.3	9	0.2	299	7.2	42	1.0
Pyrolysis products	126	3.0	45	1.1	222	5.4	43	1.0
Solvents	76	1.8	21	0.5	201	4.9	32	0.8
Isocyanates	10	0.2	15	0.4	242	5.9	4	0.1
Hydrocarbons	26	0.6	8	0.2	192	4.6	6	0.1
Mold	56	1.4	5	0.1	144	3.5	13	0.3
Polymers	26	0.6	6	0.1	142	3.4	11	0.3

Prevalence of work-related asthma

People who have WRA have similar symptoms as individuals who have asthma that is not attributed to their work, making it difficult to identify WRA. The National Heart Lung and Blood Institute recommends that clinicians ask patients who are employed and have asthma, particularly those with new-onset disease, about possible occupational exposures. “Early recognition and control of workplace exposures is important and the patient may fail to recognize the relationship with work, because symptoms often begin several hours after exposure.”¹

To diagnose WRA, healthcare providers need to ask detailed questions about individuals’ workplaces, assessing occupational exposures and differences in symptoms during the work week and weekends or time off from work. Medication treatment guidelines for WRA are identical to non-work-related asthma and are guided by the NHLBI.¹

Among New Hampshire adults with current asthma, a significantly higher proportion of those reporting they thought their asthma had been caused or aggravated by a previous job were currently unable to work (15.5 percent) or were unemployed or out of work (11.8 percent) compared with those not reporting their asthma was caused or aggravated by a previous job (5.2 percent and 4.3 percent) (Table 14).

Table 14

Current employment status	<i>Asthma caused or aggravated by previous job</i>		<i>Asthma NOT caused or aggravated by previous job</i>	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval
Employed for wages	38.1	31.0-45.1	60.6	55.6-65.5
Self-employed	6.6	2.9-10.4	9.4	6.3-12.4
Out of work	11.8	6.6-17.1	4.3	2.0-6.5
Student or homemaker	12.5	6.2-18.9	9.5	6.3-12.8
Retired	15.4	11.4-19.5	11	8.9-13.2
Unable to work	15.5	11.1-19.9	5.2	3.6-6.9

New Hampshire adults with current asthma were asked on the 2006–2010 ACBS if they were ever told by a doctor or other medical person that their asthma was related to any job they ever had.

Approximately 7 percent of New Hampshire adults with current asthma reported they had been told by a health care provider they had WRA (95% confidence interval: 5.2–9.0). This represents approximately 7,000 New Hampshire adults who have been diagnosed with WRA.

Among New Hampshire adults with current asthma, the proportion aged 55 to 64 years reporting a diagnosis of WRA was significantly higher than the proportion aged 18 to 44 years or 65 years or older. No other differences by demographic characteristics were found in the proportion reporting a diagnosis of WRA (Table 15).

Table 15

NH adults with current asthma reporting they had ever been told by a doctor or other health professional they had work-related asthma by demographic characteristics, 2006–2010 ACBS		
Characteristic	Percent	95% Confidence Interval
Total	7.0	5.2 - 9.0
Sex		
Male	8.1	3.9 - 12.2
Female	6.6	4.7 - 8.4
Age		
18 to 44	5.6	2.7 - 8.6
45 to 54	7.7	3.6 - 11.9
55 to 64	12.5	8.7 - 16.4
65 or older	5.2	2.7 - 7.6
Education		
High school diploma, GED or less	9.5	4.4 - 14.5
Some college, tech school or college graduate	6.2	4.5 - 8.0
Income		
Less than \$50,000	8.8	5.2 - 12.4
\$50,000 or more	5.8	3.4 - 8.2

Respondents to the ACBS were also asked if they thought their asthma was caused or made worse by chemicals, smoke, fumes or dust in their current job or in a previous job. No significant differences were found by demographic characteristics in the proportion of New Hampshire adults with current asthma reporting they thought their asthma was caused or aggravated by their current job (Table 16).

Table 16

NH adults with current asthma reporting their asthma was caused by or aggravated by their current job, by demographic characteristics, 2006–2010 ACBS		
Characteristic	Percent	95% Confidence Interval
Total	26.3	20.7 - 31.9
Sex		
Male	27.3	19.0 - 35.5
Female	25.9	20.7 - 31.2
Age		
18 to 44	23.6	16.9 - 30.2
45 to 54	30.9	23.2 - 38.7
55 to 64	29.1	20.1 - 38.0
65 years or older	38.4	22.2 - 54.6
Education		
HS, GED or less	29.2	19.5 - 39.0
Some college, tech school or more	25.7	20.5 - 30.9
Income		
Less than \$50,000	28.6	20.0 - 37.2
\$50,000 or more	25.2	19.7 - 30.7

Analysis of reported diagnosis with respondent’s assessment of impact of work on their asthma suggests there may be a substantial amount of under-diagnosis of WRA in New Hampshire. Among those who did not report a WRA diagnosis, 37.5 percent reported they thought their asthma was caused or aggravated by their current job or a previous job (Table 17). This represents approximately 34,000 New Hampshire adults.

There is not enough information to determine whether these individuals had been assessed by a medical provider for WRA and had WRA ruled out or, if they were actually undiagnosed. It is reasonable to expect, however, that some proportion of these individuals were in need of medical assessment for WRA.

Table 17

NH adults with current asthma reporting their asthma was caused or aggravated by a current or previous job, by whether they were ever told by a health care provider they had work-related asthma, 2006–2010 ACBS		
Ever Told by a Doctor They Had WRA	Percent	95% Confidence Interval
Yes	97.7	95.6 - 95.6
No	37.5	33.2 - 33.2

Industries and occupations

Nationally, asthma prevalence was highest among adults employed in service industries (Table 18). Health services occupations had the highest prevalence of U.S. adults with asthma. Please note this refers to all types of asthma, not only WRA.¹⁰

Table 18

Selected estimates of asthma prevalence among U.S. adults 18 years or older by industry and occupation where prevalence estimates exceeded 10%, United States, 1997–2004 National Health Interview Survey¹⁰

Industry	Percent	95% Confidence Interval
Social services, religious and membership organizations	11.2	10.2 - 12.1
Health services, except hospitals	10.9	10.2 - 11.7
Eating and drinking places	10.9	10.0 - 11.8
Banking and credit agencies	10.7	9.5 - 11.9
Elementary and secondary schools and colleges	10.5	9.9 - 11.1
Other educational services	10.4	8.0 - 12.7
Legal, engineering and other professional services	10.1	9.3 - 11.0
Food bakery and dairy stores	10.1	8.9 - 11.3
Business services	10.0	9.2 - 10.7
Occupation		
	Percent	95% Confidence Interval
Health service	11.5	10.3 - 12.7
Health technologist and technicians	11.5	10.0 - 13.0
Forestry and fishing	11.4	5.9 - 16.9
Other professional specialty	11.2	10.0 - 12.4
Personal service	11.1	9.8 - 12.3
Teachers, librarians, and counselors	10.9	10.2 - 11.7
Food service	10.8	9.8 - 11.7
Other administrative support	10.6	10.0 - 11.1
Architects and surveyors	10.5	6.6 - 14.4
Financial records processing	10.4	9.0 - 11.9
Other sales	10.4	9.6 - 11.2
Secretaries, stenographers, and typists	10.4	9.2 - 11.5
Writers, artists, entertainers, and athletes	10.3	9.1 - 11.5
Health assessment and treating occupations	10.0	8.9 - 11.0

In New Hampshire, adults employed in the food service industry had the highest prevalence of current asthma in 2008 (Table 19). There were, however, no statistically significant differences found in current asthma prevalence by industry. Asthma prevalence by industry in New Hampshire was similar to national estimates by industry where individuals in the education, food related and health care industries had some of the highest asthma prevalence estimates (Table 19).

Table 19

NH adults with current asthma by reported industry, 2008 NH BRFSS		
Industry	Percent	95% Confidence Interval
Food Service	14.1	7.2 - 21.1
Wholesale or retail sales	14.0	8.6 - 19.4
Education	13.5	9.6 - 17.4
Agriculture, fishing, hunting	11.7	1.7 - 21.8
Business and technical services	10.4	6.7 - 14.0
Health care	10.4	7.7 - 13.0
Utilities or mining	10.2	2.0 - 18.4
Other	9.2	3.7 - 14.7
Manufacturing	8.6	4.6 - 12.6
Other Service Industry and accommodations	8.6	5.0 - 12.1
Finance, Insurance, Real Estate	7.8	3.9 - 11.7
Government (local, state, federal)	7.0	3.8 - 10.2
Construction	5.3	1.9 - 8.8
Transportation and warehousing	4.4	0.4 - 8.5

Impact of work-related asthma

Figure 6 and Table 20 display the proportion of New Hampshire adults with current asthma reporting symptoms, episodes and health care utilization by perception of the impact their work has on their asthma. Results suggest a statistically significant association between asthma exacerbation, care utilization, and perception of WRA, but care should be used in interpretation since the ACBS data are cross-sectional with symptoms and assessment of work impact reported at the same time.

Figure 6

NH adults with current asthma reporting impact on quality of life and health care utilization by whether respondent reported asthma was caused or aggravated by current job, 2006-2010 ACBS

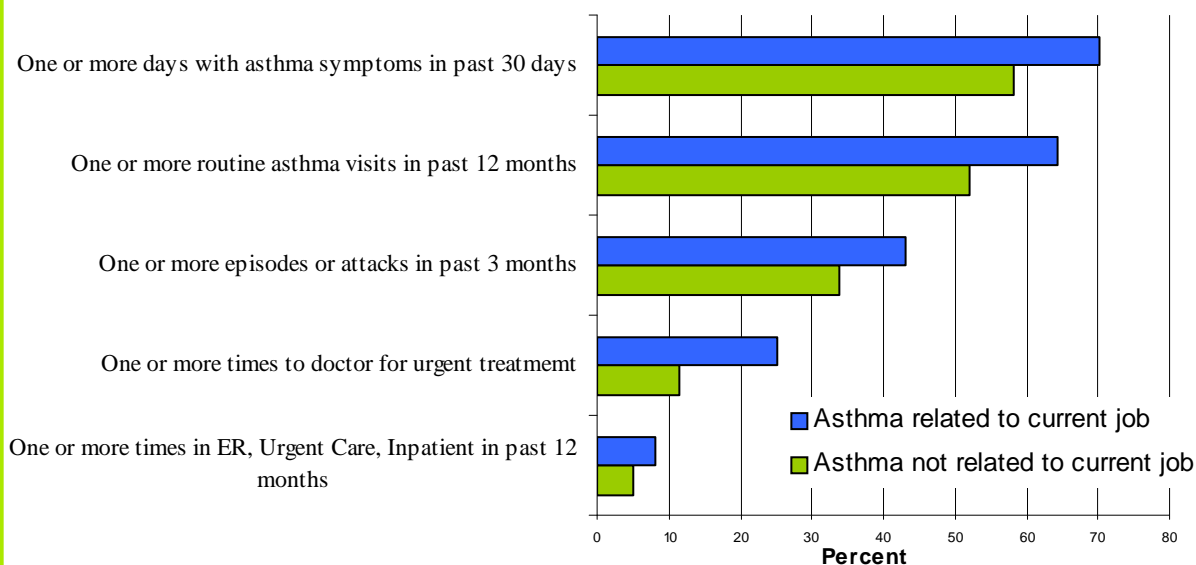


Table 20

NH adults with current asthma reporting impact on quality of life and health care utilization by whether respondent reported asthma was caused or aggravated by current job, 2006-2010 ACBS

<i>NH Adults with current asthma</i>	<i>Asthma caused or aggravated by current job</i>		<i>Asthma not caused or aggravated by current job</i>	
	Percent	95% Confidence Interval	Percent	95% Confidence Interval
One or more times in ER, Urgent Care Center, Inpatient in past 12 months	8.0	3.9 - 12.1	5.0	2.5 - 7.6
One or more times to HP for urgent treatment	25.3	17.7 - 32.9	11.5	7.8 - 15.3
One or more episodes or attacks in past 3 months	43.1	33.5 - 52.7	33.8	27.8 - 39.8
One or more routine asthma visits in past 12 months	64.3	54.6 - 74.1	52.1	46.0 - 58.3
One or more days with asthma symptoms in past 30 days	70.2	60.4 - 80.1	58.3	52.2 - 64.4

The economic impact of WRA can be significant for affected individuals as well as employers. WRA is associated with a high rate of unemployment and loss of income, increased utilization of health care resources, and an adverse impact on quality of life.¹²

Prevention of work –related asthma

Environmental interventions along with appropriate medication regimens are often needed to effectively control WRA. By identifying problems early on, employers can prevent other workers from developing work-related asthma.

Key things to remember about WRA¹³

- Symptoms of work-related asthma usually occur while or after a worker is exposed to a particular substance at work. However, some workers will only get symptoms many hours after leaving work.
- Symptoms usually go away during weekends or vacation and return after going back to work.
- Work-related asthma is usually reversible, but permanent lung damage, or even death, can occur if exposure to the substance that causes the disease continues. In some workers, very small amounts of the substance can cause an asthma episode.

Steps employers can take to prevent WRA

- Substitute asthma-causing agents with less hazardous chemicals or substances. For example, cleaning chemicals are one of the most common substances associated with work-related asthma. Because cleaning products impact indoor air quality, they affect not just the janitorial staff but all employees in the building. Employers can alleviate this problem by using “green” cleaning products.
- Follow instructions on Material Safety Data Sheets (MSDS) on proper safety and use of all chemicals.
- Keep exposures as low as possible using engineering controls such as local exhaust ventilation and monitor exposures regularly.
- Provide respiratory protection to workers at risk of exposure to hazards if none of the options above can be implemented - make sure employees are medically evaluated prior to use. See the U.S. Occupational Safety and Health Administration (OSHA) for additional guidance.
- Train workers how to recognize the signs of breathing problems.
- Assign any employee who develops asthma to a non-exposed job as soon as they are identified.

What employees can do if they suspect they have WRA

- Document their symptoms: when symptoms occur and what they were doing at the time.
- Talk to their doctor about their symptoms and exposures.
- See an asthma specialist.
- Communicate with their employer and any employee health program at their place of employment.
- If there is evidence of WRA, request a position change to reduce harmful exposure. Your doctor can provide supporting documentation.

Work-related asthma is under-diagnosed because most physicians do not inquire whether symptoms are work-related. They can improve diagnosis of WRA by asking the following:

- Is this new-onset asthma?
- Did asthma symptoms develop or worsen with a new job or introduction of new materials?
- Do asthma symptoms develop within minutes of specific activities or exposures at work?
- Do symptoms improve away from work or on vacation?
- Do symptoms worsen on return to work after being away?

Outdoor Environment

The NHLBI EPR3 recommends that clinicians advise patients to avoid, to the extent possible, exertion or exercise outside when levels of air pollution are high.¹

Under the Clean Air Act, signed into law in 1970, EPA establishes air quality standards for six “criteria” air pollutants. These criteria pollutants are ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead. Standards protect public health, including the health of "sensitive" populations such as people with asthma, children, and older adults.¹⁴

The New Hampshire Department of Environmental Services (DES) maintains air monitoring stations across the sState, measures the concentration of these criteria pollutants on an hourly basis, and issues alerts when concentrations exceed EPA standards.¹⁵

These alerts are based on the EPA Air Quality Index (AQI), which rates air quality based on the potential impact on public health. An AQI over 100 is considered dangerous for sensitive populations such as people with asthma.¹⁶

Two of six criteria air pollutants monitored by DES are ground level ozone and fine particulates. High concentrations of these can make breathing difficult, exacerbate asthma, and cause long-term damage to lungs.¹⁷

Ground level ozone

Ozone can be found both high up in the earth’s atmosphere and close to the ground. Ozone in the upper atmosphere forms naturally, creating a barrier that protects the earth from the sun’s ultraviolet radiation.¹⁸ However, ozone found in the lower atmosphere, in the air around us, can make breathing difficult, especially for sensitive populations such as the very young and very old and for people with health conditions such as asthma. This ground level ozone forms from other chemical compounds called ozone precursors (including nitrogen oxides and volatile organic compounds) that combine in the presence of sunlight.¹⁸

Ground level ozone precursors are emitted from man-made sources including industrial facilities, power plants, landfills, and motor vehicles (Figures 7 and 8) as well as from natural sources such as lightning, soil and trees. Because ozone forms in the presence of sunlight, elevated ground level ozone in New Hampshire occurs on warm, sunny days in the spring and summer.^{19,20}

Figure 7

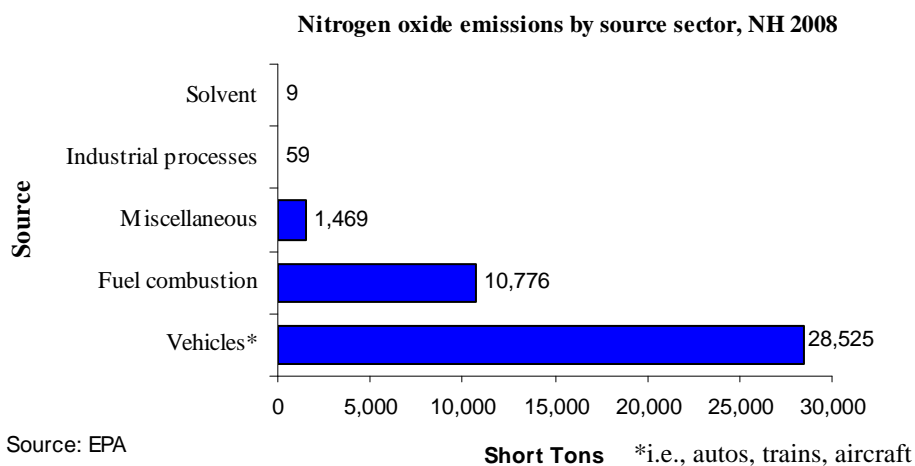
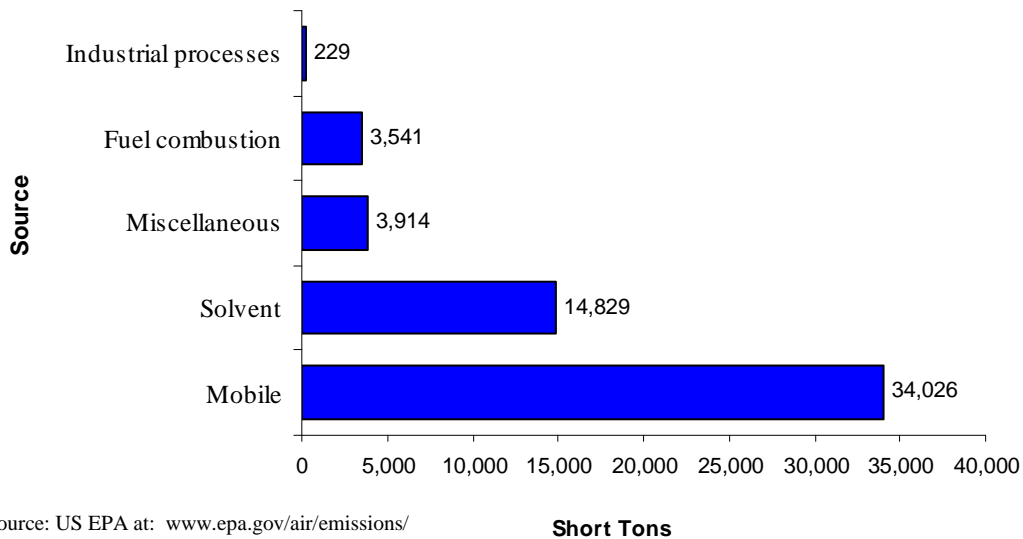


Figure 8

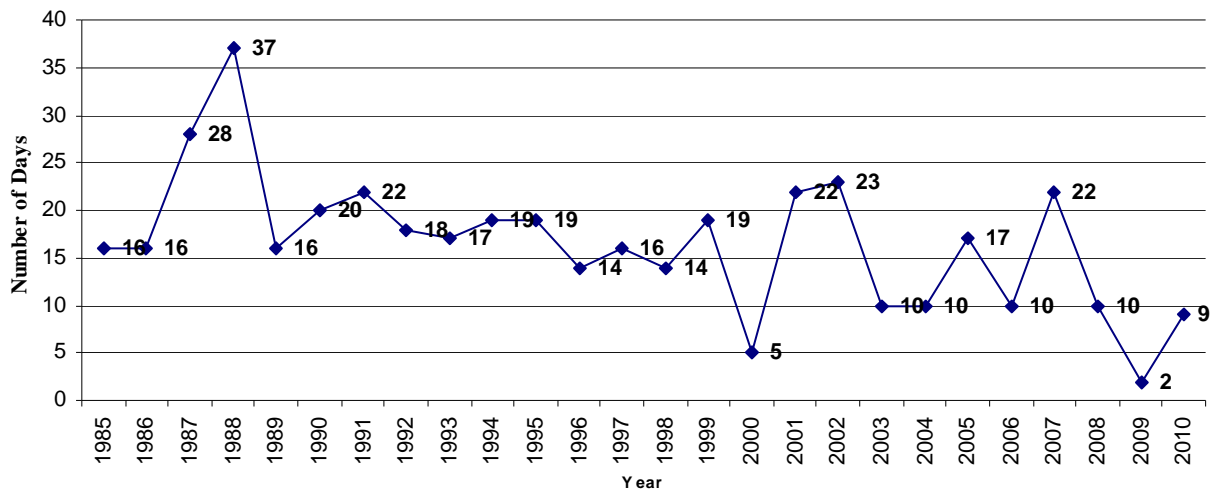
Volatile organic compound emissions by source sector, NH 2008



EPA reports that nationally, average ground level ozone concentrations were 10% lower in 2008 compared to 2001.²⁰ New Hampshire data, reported by DES, mirror that trend (Figure 9).²¹

Figure 9

Number of days EPA standard for ozone was exceeded, New Hampshire 1985-2011



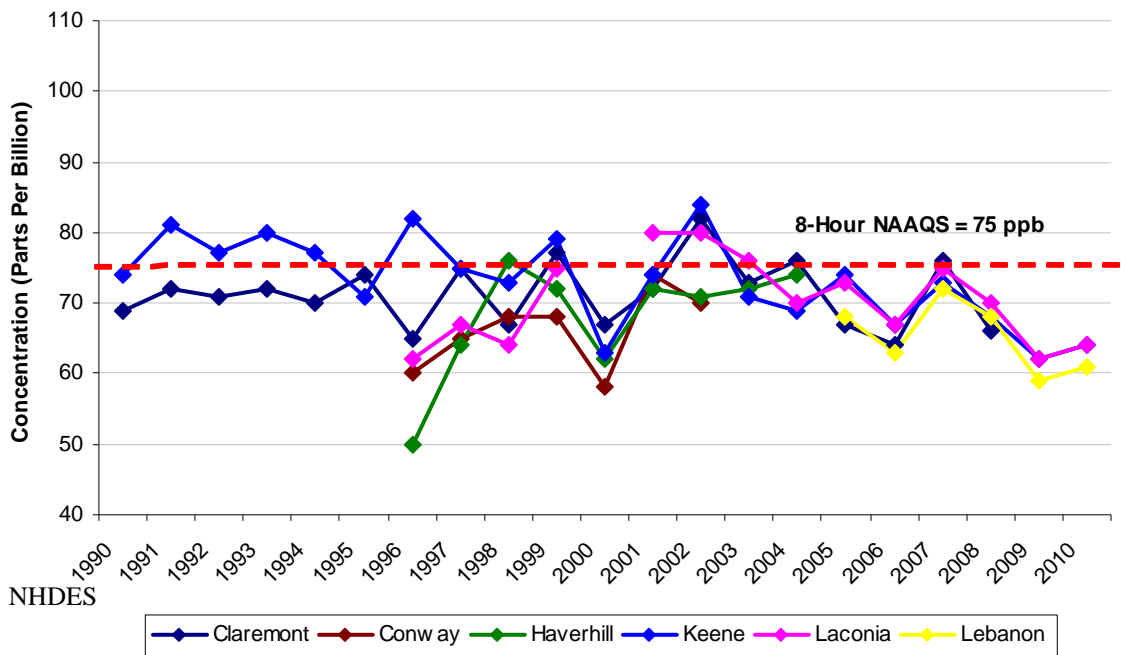
Source: NH Department of Environmental Services

While ground level ozone concentrations have declined in New Hampshire over time, some areas of the State continue to experience days when ozone concentrations reach dangerous levels.

Ground level ozone can form locally in New Hampshire, but much of it is transported by air currents from neighboring states to the south and west.¹⁹

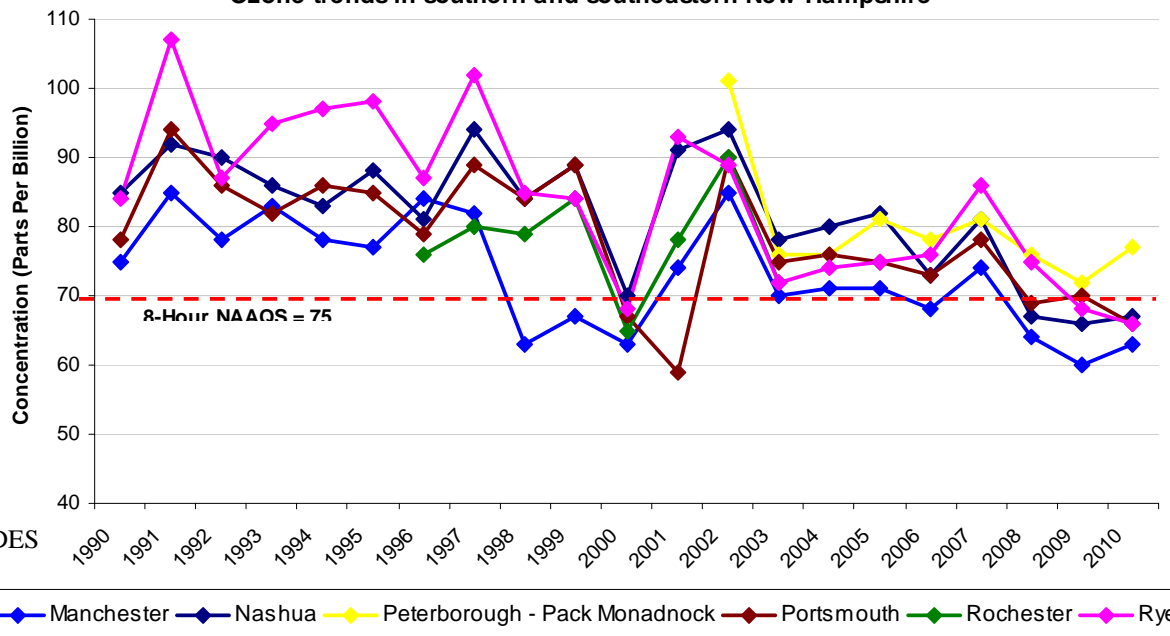
Generally, concentrations of ground level ozone tend to be higher in southern New Hampshire than in the north (Figures 10, 11, 12). An exception is the monitor on the summit of Mt. Washington where ozone levels are consistently elevated. This is very likely evidence of ozone being transported from other areas, called long-range transport. As further evidence of long range transport, the Camp Dodge monitor, located at the base of Mt. Washington, usually records lower ozone concentrations than those seen at the summit (Figure 12).¹⁹

Figure 10
Ozone trends in northern and western New Hampshire



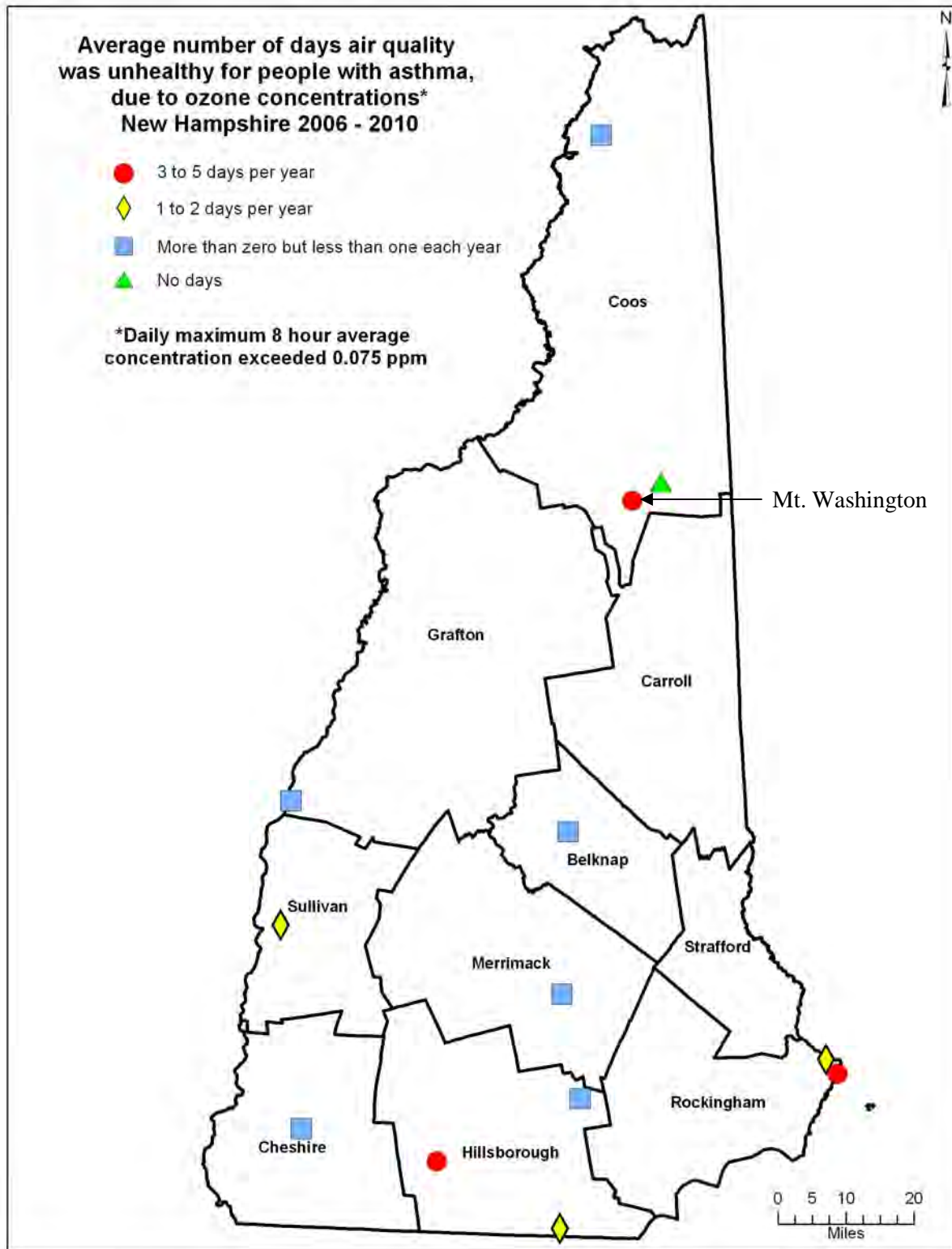
Source: NHDES

Figure 11
Ozone trends in southern and southeastern New Hampshire



Source: NHDES

Figure 12

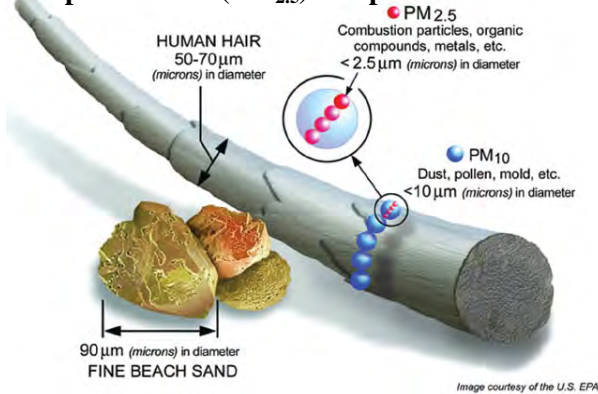


Analysis by New Hampshire Asthma Control Program, Data Source: US. EPA Air Explorer²²

Fine particulates

A second EPA criteria air pollutant that can exacerbate asthma symptoms is fine particulates. Fine particulates are mixtures of solid particles and liquid droplets and are often referred to as PM_{2.5} due to their size, generally less than or equal to 2.5 micrometers (µm). Figure 13 illustrates the size of fine particulates compared with a human hair and a grain of sand.²³

Figure 13
Fine particulates (PM_{2.5}) compared with the size of a human hair and a grain of sand

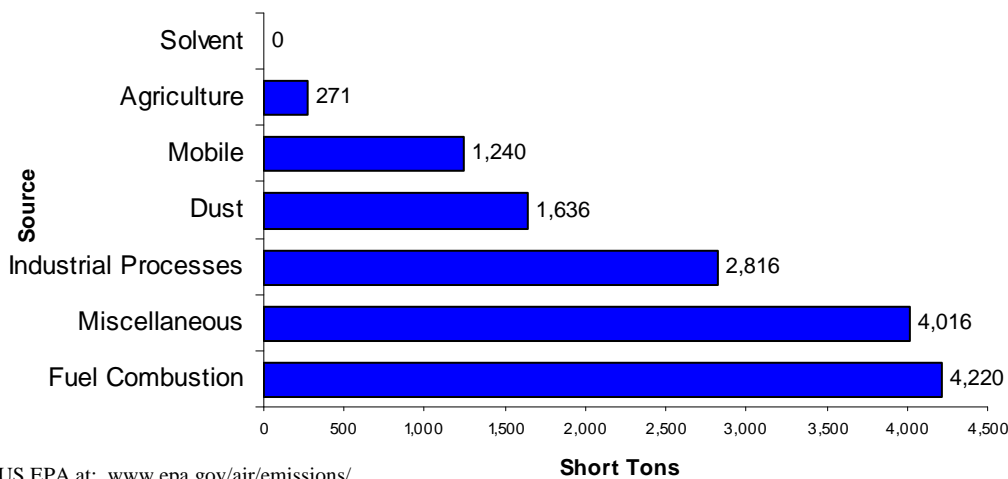


Fine particulates can enter the lung, causing lung damage, bronchitis and exacerbations of asthma. As well as being found in outdoor air, fine particulates can also enter homes when outdoor concentrations are high.²³

Fine particulates can come from windblown dust, crushing and grinding operations, unpaved roads, fuel combustion (including motor vehicles and wood stoves), and from agricultural operations as well as from natural sources such as forest fires (Figure 14).^{23,24}

Figure 14

PM_{2.5} emissions by source sector, NH 2008



Source: US EPA at: www.epa.gov/air/emissions/

While overall concentrations of PM₂₅ are generally low in New Hampshire, some areas see seasonally higher levels in the winter due to their surrounding geography, weather patterns and use of wood burning for heat.

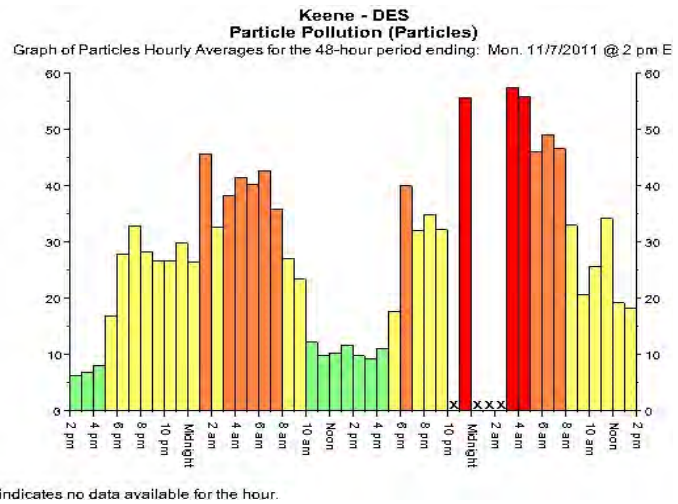
For example, Keene, New Hampshire is located in a valley surrounded by high hills, including Mount Monadnock in southwestern New Hampshire. On cold, calm days, when residents are using wood stoves to heat their homes, temperature inversions can trap smoke and particulates in the valley. These conditions can increase local concentrations of air pollutants, especially particulates.²⁴

To illustrate the impact of these temperature inversions on areas in New Hampshire, Figure 15 shows the average state concentrations for particulates during a day in November 2011. While the average AQI for the State was good with a moderate index in Cheshire County where Keene is located, the hourly data for Keene show periods when the AQI was in the unhealthy range.¹⁵

Figure 15

Map of Air Quality for:
 Tuesday, November 7 2011
 Primary Pollutant: Fine Particles, NH
 DES Air Quality Current Data

Keene Air Quality from Particulates, November 7, 2011, NH
 DES Air Quality Current Data



Actions to reduce or avoid irritants in outdoor air

DES issues air quality alerts, also known as Air Quality Action Days when outdoor air concentrations of criteria pollutants reach dangerous levels. These alerts are based on the EPA’s Air Quality Index (AQI), which ranks air quality based on the concentrations of pollutants reported from state monitoring stations. AQI values over 100 are considered unhealthy for sensitive populations such as people with asthma.¹⁶

Sensitive members of the population, such as people with asthma, should monitor air quality in their areas and limit their outdoor activities when air quality is poor. When particulate levels are high, people with asthma should also consider limiting indoor activities since particulates may enter homes and other buildings.

Use of more efficient fuels during winter heating months may reduce local levels of air pollution. The amount of smoke from wood stoves can be reduced by using EPA-certified wood stoves and using good quality firewood.²⁴ New Hampshire DES web pages have more information on improving efficiency of wood stoves at http://des.nh.gov/organization/divisions/air/cb/ceps/npsap/wood_stoves.htm.

Awareness of air quality

In 2007, the BRFSS measured awareness among New Hampshire adults of air quality alerts and their response to reduced air quality conditions. Results show that 67 percent of New Hampshire adults with current asthma had heard or read about the Air Quality Index (AQI) or air quality alerts such as New Hampshire’s Air Quality Action Days (AQAD). This proportion was not significantly different from that of adults without current asthma (Table 21).

A significantly higher proportion of adults with current asthma reported changing their activity level in response to air quality alerts compared with adults without current asthma (Figure 16, Table 24).

Table 21

NH adults reporting they ever heard of the AQI or air quality alerts such as NH’s AQAD by current asthma status, 2007 NH BRFSS		
Asthma Status	Percent	95 % Confidence Interval
Current asthma	66.5	60.9 - 72.2
No current asthma	68.0	66.3 - 69.7

Figure 16

Proportion of NH adults reporting they had changed their activity level the indicated number of times due to air quality alerts, by current asthma status, 2007 NH BRFSS

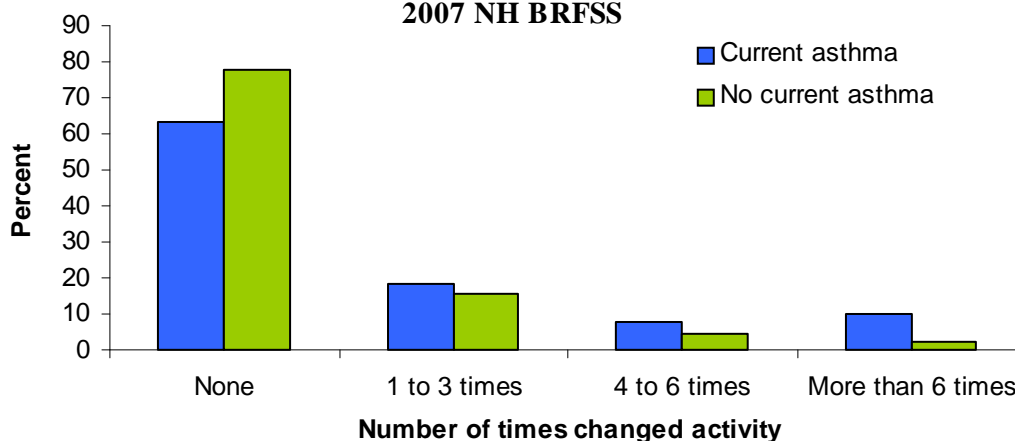


Table 24

NH adults reporting they had changed their activity level in the previous 12 months due to air quality alerts, by current asthma status, 2007 NH BRFSS

Number of Times Changed Activity Level	<i>Current asthma</i>		<i>No current asthma</i>	
	Percent	95 % Confidence Interval	Percent	95 % Confidence Interval
None	63.6	57.8 - 69.4	77.8	76.1 - 79.6
1 to 3 times	18.2	13.7 - 22.7	15.5	14.0 - 17.0
4 to 6 times	8.0	4.8 - 11.2	4.3	3.5 - 5.2
More than 6 times	10.2	6.7 - 13.6	2.3	1.8 - 2.9

In 2007, 29% of New Hampshire adults with current asthma reported they had been told by a health care professional they should reduce their outdoor activities when the air quality is bad. While low, this proportion was still significantly higher than that of adults without current asthma (Table 25).

Table 25

NH adults reporting a doctor, nurse, or other health professional ever told them to reduce outdoor activity level when the air quality is bad, by current asthma status, 2007 NH BRFSS		
	Percent	95 % Confidence Interval
Current asthma	28.8	24.3 - 33.3
No current asthma	6.1	5.3 - 6.9

The proportion of New Hampshire adults with current asthma reporting they limited their activities during bad air quality days was significantly higher among those reporting they had been advised to do so by a health care professional than among those not reporting provider advice (Table 26).

Table 26

NH adults with current asthma reporting they changed their activity level one or more times due to bad air quality, by whether they reported health professional advice to do so, 2007 NH BRFSS		
	Percent Reporting Reducing Activity	95% Confidence Interval
Advised by HCP	Levels	
Yes	60.0	51.7 - 68.2
No	18.8	14.2 - 23.4

The percentage of New Hampshire adults with current asthma reporting they had been advised by a doctor, nurse, or other health professional to limit their outdoor activities if air quality was bad was significantly higher among women compared with men, among adults aged 45 or older compared with adults aged 18 to 34 years, and among adults with current asthma who had a household income of less than \$25,000 compared with those with a household income of \$75,000 or more (Figure 17, Table 27).

Figure 17

NH adults with current asthma advised by a health care provider to limit their outdoor activities if air quality was bad, by demographic characteristics, 2007 BRFS

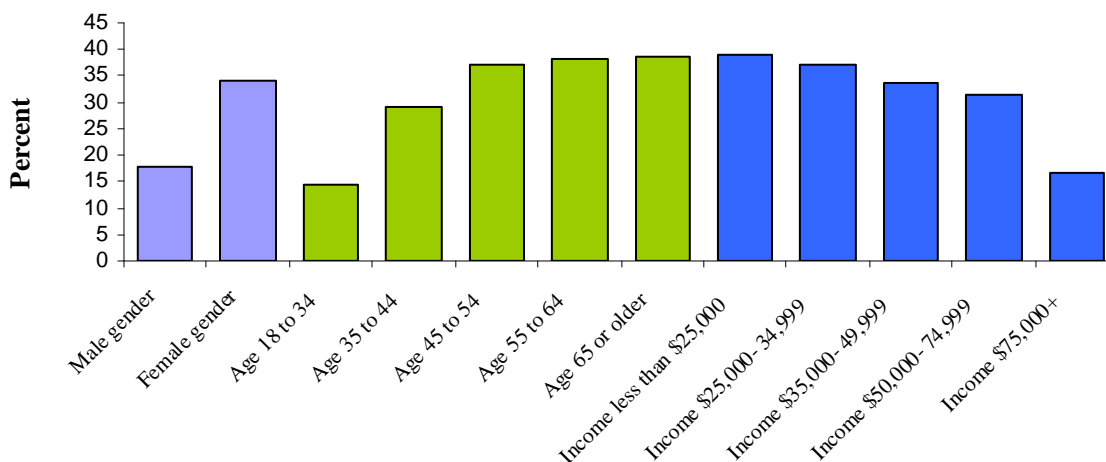


Table 27

Percent of NH adults with current asthma advised by a health care provider to limit their outdoor activities if air quality was bad, by demographic characteristics, 2007 BRFS

Characteristic	Percent	95% Confidence Interval
Total	28.8	24.3 - 33.3
Sex		
Male	17.8	10.5 - 25.0
Female	34.2	28.9 - 39.6
Age		
18 to 34	14.4	6.5 - 22.3
35 to 44	29.1	20.4 - 37.9
45 to 54	37.1	26.9 - 47.3
55 to 64	38.2	27.3 - 49.2
65 or older	38.6	28.8 - 48.3
Education		
Less than HS or GED	30.7	16.6 - 44.9
HS or GED	29.1	20.0 - 38.2
Some college or tech school	25.9	17.5 - 34.3
College grad (4 years or more)	30.3	23.0 - 37.5
Income		
Less than \$25,000	38.8	28.7 - 48.8
\$25,000- 34,999	36.9	20.9 - 52.8
\$35,000- 49,999	33.5	20.8 - 46.2
\$50,000- 74,999	31.5	19.6 - 43.4
\$75,000+	16.8	10.0 - 23.6

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