

ASTHMA IN THE WORKPLACE

Surveillance of Work-Related Asthma in New York State

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Objective. The objective of this paper is to determine the percent of adults with asthma attributable to work and describe characteristics of the work-related asthma population in New York State. Sociodemographic and control characteristics of those with and without work-related asthma are compared. **Methods.** Data from three population-based surveys and one case-based surveillance system were analyzed. Work-relatedness of asthma was determined by self-report for the population-based surveys and by physician report for the case-based system. Self-reported sociodemographic and control characteristics were analyzed for the population-based surveys by work-relatedness. **Results.** The percent of work-relatedness among adults with current asthma in New York State ranged from 10.6% to 44.5%. Significantly more adults with work-related asthma had poorly controlled asthma than those without work-related asthma. More adults with work-related asthma also tended to be employed in the manufacturing, educational services, and public administration industries than the general population. The most frequently reported exposure was dust. **Conclusions.** Adults with work-related asthma have decreased control and adverse socioeconomic impacts compared to those with asthma that is not work-related. Increased recognition and physician reporting is necessary to further prevent the impact of work-related exposures.

Keywords asthma, control, occupational, workers, work-related, control

INTRODUCTION

Asthma is a chronic inflammatory disease of the airways that affects more than 16 million adults in the United States (1). Work-related asthma (WRA) is a term used to describe asthma that has a temporal association between asthma symptoms and the work environment (2).

There are different types of WRA and the implications of the disease can vary by type (3). WRA can be classified into new-onset asthma or work-aggravated asthma. New-onset asthma occurs when there were no previous asthma symptoms or medication use 2 years prior to occupational exposures (4). If new-onset asthma occurred after a one-time high-level inhalation exposure with symptoms that persist for at least 3 months, it is termed reactive airway dysfunction syndrome (RADS) (5). RADS is the most definitive form of irritant-induced asthma because there is no latency period (6). Otherwise, new-onset WRA is classified as occupational asthma (OA). Work-aggravated asthma (WAA) occurs when a patient has preexisting asthma and has experienced increased asthma symptoms or increased use of asthma medication due to occupational exposures. Definitions of WRA are not mutually exclusive and overlaps in diagnosis can occur. For example, a sensitizer can cause OA while another exposure can cause WAA in the same worker (6).

In the United States and other industrialized countries, asthma with an occupational etiology causes a largely unrecognized burden of preventable disease and disability (7). Over the past decade, WRA, including both OA and WAA, has become the most common chronic occupational disease in industrialized countries. The consensus is that between 10% and 15% of adult-onset cases of current asthma are due

to occupational exposures, which translates to approximately 1.6 to 2.4 million adults in the United States (6). Definitive diagnoses of WRA can be complicated by the difficulty in distinguishing it from asthma caused by nonoccupational etiologies (8). Although WRA looks and acts the same as non-WRA, WRA is largely preventable. If diagnosed early, WRA may be partially or completely reversible if exposures can be identified and properly stopped or controlled (6, 7). Research has shown that WRA can have adverse effects on the worker, including increased morbidity, adverse socioeconomic impacts, and difficulty getting and sustaining work (9–11). In addition, adults with WRA may have more severe asthma with less control, resulting in frequent health care utilization, placing a larger burden on physicians and health care facilities (9–11). Over 350 substances have been associated with WRA (12), putting millions of workers at risk and resulting in an estimated \$1.5 billion in direct and indirect costs to businesses, health care, and the economy each year (13).

The New York State (NYS) Department of Health (DOH) conducts both population- and case-based surveillance of WRA in NYS. The National Institute for Occupational Safety and Health (NIOSH) funds other state-based surveillance and intervention programs for WRA in California, Massachusetts, Michigan, New Jersey, and Washington. These states have developed a surveillance case definition for WRA, which requires that a health professional must diagnosis asthma and establish an association between symptoms and work (3). NYSDOH defines WRA in accordance with this definition.

METHODS

Multiple methods are used to conduct surveillance of WRA in NYS. Population-based surveys that have collected data on WRA include the NYS National Asthma Survey (NAS-NYS), the Behavioral Risk Factor Surveillance

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Table 1.—Survey questions for determining asthma and work-related components, by data source.

Survey question	NAS-NYS	BRFSS	ACBS	Component determined
Screening Questions				
Have you ever been told by a doctor, nurse, or other health professional that you had asthma?	X	X	X	Lifetime asthma
Do you still have asthma?	X	X	X	Current asthma
WRA Questions				
Was your asthma caused or made worse by chemicals, smoke, fumes or dust in any job you ever had? (Q1) ^a	X			Work-related asthma
Were you ever told by a doctor, nurse, or other health professional that your asthma was related to any job you ever had? (Q2)		X	X	Work-related asthma
Did you ever tell a doctor, nurse, or other health professional that your asthma was related to any job you ever had? (Q3)		X	X	Work-related asthma
Was your asthma caused by chemicals, smoke, fumes or dust in your current job? (Q4). Is your asthma made worse by chemicals, smoke, fumes or dust in your current job? (Q5). Was your asthma caused by chemicals, smoke, fumes, or dust in any previous job you ever had? (Q6). Was your asthma made worse by chemicals, smoke, fumes or dust in any previous job you ever had? (Q7). (Q4–Q7) ^b			X	Work-related asthma
Did you ever change or quit a job because chemicals, smoke, fumes or dust caused your asthma or made you asthma worse? (Q8)			X	Work-related asthma

^aThis question was asked only of respondents who answered yes to at least one of the following questions: (1) Have you spoken to a doctor or health professional about your asthma within the last 3 years? (2) Have you taken asthma medication within the last 3 years? (3) Have you had any symptoms of asthma within the last 3 years?

^bAn affirmative response to any of those questions, Q4–Q7, indicated WRA.

System (BRFSS), and the Asthma Call-Back Survey (ACBS). Case-based surveillance is conducted through the NYSDOH Occupational Lung Disease Registry (OLDR).

Population-Based Surveillance

Sponsored by the Centers for Disease Control and Prevention (CDC) and the NYSDOH, the NAS-NYS was conducted from July 2002 through August 2003 (22). The survey methodology and weighting procedures are described elsewhere (14, 15). A total of 11,713 households were screened for asthma, and of those households, 1323 adults (18+ years old) completed a detailed asthma interview. Lifetime asthma (e.g., ever having a diagnosis of asthma) and current asthma (e.g., still having asthma symptoms) were determined by two screening questions (Table 1). A WRA case was defined as having current asthma and a “yes” response to one WRA question (Table 1 Q1).

The NYS BRFSS is an annual statewide random digit dialing telephone survey of the noninstitutionalized adult population aged 18 years and older (16). The survey methodology and weighting procedures are described elsewhere (16). NYS added two WRA questions to the survey in 2002, 2003, and 2005 (Table 1 Q2, Q3) (7). For the 3 years combined, there were 17,806 respondents, of which 1533 had current asthma.

Asthma cases were identified as lifetime and current by two screening questions (Table 1). WRA cases were defined as having a discussion about WRA with a health professional (yes to either Q2 or Q3).

In 2006 and 2007, NYS BRFSS respondents with lifetime asthma were eligible to participate in the ACBS (17). The survey methodology and weighting procedures have been published elsewhere (17, 18). For the combined years, 750 adults in NYS completed the ACBS. The two WRA questions from BRFSS (Table 1 Q2, Q3) were used, along with five additional questions to determine work-relatedness. Through a series of four questions (Table 1 Q4 to Q7), respondents who had ever been employed outside the home were asked if their asthma was caused or made worse by chemicals, smoke, fumes, or dust in their current or previous job. In addition, respondents were asked if they had ever changed or quit a job because of exposures (Table 1 Q8). An affirmative response to any of these questions classified the respondent as having WRA.

From all three population surveys, demographics collected as part of the interview were used for comparison between the WRA and the non-WRA groups. Other information collected included current employment status, reason why not employed, smoking history, body mass index, frequency and

Table 2.—Classification of asthma symptoms and control for adults with current asthma.

Components of control ^a	Classification of asthma control		
	Well controlled	Not well controlled	Very poorly controlled
Symptoms	≤2 days/week	>2 days/week	Throughout the day
Nighttime awakenings	≤2×/month	1–3×/week	≥4×/week
Interference with normal activities	None	Some limitation	Extremely limited
Short-acting beta-agonist use for symptom control	≤2 days/week	> 2 days/week	Several times per day

^aAsthma control was calculated using components of control without non-missing values.

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Table 3.—Percent of WRA, based on data source and survey question, among adults with current asthma, NYS BRFSS 2002, 2003, 2005 and NYS ACBS 2006, 2007.

	BRFSS% (95% CI)	ACBS% (95% CI)
Q2 ^a Told by Health Professional that asthma was work-related	6.8% (5.5–8.5)	11.6% (7.6–15.5)
Q3 ^a Told a Health Professional that asthma was work-related	7.7% (6.1–9.7)	13.6% (9.5–17.6)
Yes to either Q2 or Q3 ^a	10.6% (8.7–12.7)	16.9% (12.3–21.4)

Note. All percentages are weighted.
^aQuestions Q2 and Q3 can be found in Table 1.

type of asthma medication used, activity limitations, and frequency of symptoms.

Asthma control for both ACBS and NAS-NYS respondents was based on the National Heart, Lung and Blood Institutes' National Asthma Education and Prevention Program (NAEPP) Expert Panel Report 3 (EPR-3) guidelines (19). Classification used asthma symptoms, short acting beta agonist (SABA) medication use, nighttime awakenings, and interference with normal activities due to asthma (Table 2). Based on the self-reported answers, asthma control was classified into three levels: well controlled, not well controlled, and very poorly controlled. Although the EPR-3 classification of control includes risk and lung function components, these measures were not available and could not be factored into the classification.

Case-Based Surveillance

Parts 22.4 and 22.5 of the NYS Sanitary Code requires all health care facilities and medical care providers to report suspected or confirmed occupational lung disease to the NYS OLDR, which is maintained by the NYSDOH (New York Codes, Rules, and Regulations). When a report is received, registry staff attempt to contact all potential adult (18+ years of age) WRA cases for an interview. Information collected includes demographics, industry, occupation, and exposures. All reports received between January 1, 2002, and December 31, 2007, were reviewed and those determined to be WRA were included in the analysis. All reports with a potential association of exposures from the World Trade Center (WTC) disaster were excluded because these differed from typical workplace exposures (20). Industry was classified using the 2002 North American Industrial Classification System (NAICS) (21), occupational information was classified using the 2000 Bureau of Census Occupational Codes (22), and exposures were classified using the Association

of Occupational and Environmental Clinics (AOEC) Exposure Codes (12). The percent distribution of WRA cases employed in each industry were compared using aggregate averages of adult (18+ years of age) employment data from the 2002–2007 Bureau of Labor Statistics Current Population Survey (23).

Data Analysis

Data were analyzed using SAS 9.1 (SAS Institute, Cary, NC). To account for the complex sampling design, SAS survey procedures were used to calculate weighted values, including 95% confidence intervals and *p* values. *p* values were obtained using the Wald chi-square test. A *p* value of less than .05 was considered significant. Missing responses were excluded from the final weighted percentages and 95% confidence intervals (CIs). For the purposes of this report, analysis was limited to respondents with current asthma.

RESULTS

WRA Estimates

Estimates of WRA prevalence from the population surveys were analyzed for adults with current asthma. From the NAS-NYS, 40.8% (*N* = 445, 95% CI 36.5–45.1) of respondents reported having WRA (data not shown). The 3 years of BRFSS data were used to calculate the percentage of WRA cases among adults with current asthma. The overall percentage for the 3 years was 10.6% (*N* = 153) (Table 3). Of the BRFSS respondents, 6.8% answered affirmatively to Q2 and 7.7% answered affirmatively to Q3 (Table 1). Of those with WRA, 37.5% answered yes to both Q2 and Q3 (data not shown). A slightly higher percentage of respondents from the ACBS answered either Q2 or Q3 affirmatively than from BRFSS (Table 3). Of those from the ACBS, almost half had done both, indicating an overlap between the two groups. Using a definition of WRA as any affirmative response to Q4 to Q8 (Table 1), 44.5% (*N* = 245) of the ACBS respondents indicated their asthma was work-related (Table 4). However, only 16.9% (37.9% of those with WRA) reported a discussion of WRA with a health professional (Table 3). While 30.8% of respondents reported WRA being caused or aggravated by a previous job, 8.6% quit or changed a job due to occupational exposures.

Characteristics of Adults with WRA

Respondents with current WRA from the NAS-NYS were significantly more likely to be overweight or obese, have a lower household income, and be unemployed due to a health or disability than those without WRA (Table 5). Respondents with current WRA from BRFSS were more likely to have

Table 4.—Percentage of WRA among adults reporting asthma, NYS ACBS 2006, 2007.

	Current asthmatics % (95% CI)
Q4. Caused by current job	10.5 (6.5–14.5)
Q5. Caused by previous job	20.3 (15.5–25.0)
Caused by job (yes to Q4 or Q5)	30.8 (25.3–36.3)
Q6. Aggravated by current job	15.8 (11.0–20.5)
Q7. Aggravated by previous job	29.9 (24.7–35.1)
Aggravated by job (yes to Q6 or Q7)	40.7 (35.1–46.3)
Q8. Quit or changed job due to WRA	8.6 (5.7–11.5)
All work-related asthmatics ^a (yes to any Q4–Q8)	44.5 (38.8–50.2)

Note. All percentages are weighted.
^aIndividual WRA responses are not mutually exclusive.

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Table 5.—Characteristics of adults with current asthma, with and without work-relatedness, by data source, NAS-NYS 2002–2003, NYS BRFSS, 2002, 2003, 2005, and NYS ACBS 2006, 2007.

	NAS-NYS			BRFSS			ACBS		
	WRA%	Non-WRA%	<i>p</i> value	WRA%	Non-WRA%	<i>p</i> value	WRA%	Non-WRA%	<i>p</i> value
Age of asthma onset ^a									
Child (<18)	40.559	43.156.	0.58	28.771.	54.845.2	0.002	43.756	44.155.	0.95
Adult	.5	9		3			.3	9	
Age									
18–44	47.652	54.445.	0.13	37.362.	55.744	0.0007	49.850	51.648.	0.76
45+	.4	6		7	.3		.2	4	
Gender									
Male	35.564	33.166	0.59	42.657	36.163.9	0.26	40.459	35.065.	0.37
Female	.5	.9		.4			.6	0	
Race/ethnicity									
White	58.341	64.135.	0.19	57.442.	63.236.8	0.33	69.830	73.326.	0.54
Other ^b	.7	9		6			.2	7	
Geographic region									
NYS, excl. NYC	62.537	59.041.	0.43	70.929.	65.734.3	0.29	73.726	72.927.	0.88
NYC ^c	.5	0		1			.3	1	
Smoking status									
Current or former smoker	57.442	53.047.	0.33	57.142.	48.551.5	0.11	55.644	49.950.	0.33
Nonsmoker	.6	0		9			.4	1	
Body mass index									
Under/normal	37.063	48.052.	0.02	27.772.	33.166.9	0.33	36.963	39.460.	0.68
Overweight/obese	.0	0		3			.1	6	
Education									
High school or less	30.769	33.366.	0.61	56.343.	44.755.3	0.08	43.656	37.462.	0.30
1 year of college or more	.3	7		7			.4	6	
Household income									
Less than \$25,000	33.466	24.475.	0.05	49.250.	33.966.1	0.01	39.460	29.670.	0.11
\$25,000+	.6	6		8			.6	4	
Current employment status									
Employed	58.341	52.247.	0.19	49.450.	54.245.8	0.37	55.244	57.142.	0.74
Unemployed	.7	8		6			.8	9	
Reason why unemployed									
Health/disability	47.752	32.567.	0.04	— ^d	— ^d	— ^d	45.055	30.469.	0.06
Other	.2	5					.0	6	

Note. All percentages are weighted.

^aAge of onset was calculated for BRFSS from 2005 data, the only year it was asked.

^bWhite includes non-Hispanic whites, whereas other includes Hispanics, Asians, Blacks, American Indians, and those who classified themselves as other.

^cNYC includes the five counties: Bronx, Kings, Queens, Richmond, and New York.

^dData not available.

adult-onset asthma, be 45 years of age or older, and have a household income of less than \$25,000 per year, compared to adults with current asthma not related to work (Table 5). There were no significant differences from the ACBS (Table 5).

There were some variations in the demographics of respondents with WRA across data sources. In the ACBS and NAS-NYS, age of WRA respondents was evenly distributed between the 18 to 44 and the 45 and over categories, whereas the majority from BRFSS were older than 45 years (Table 5).

Table 6.—Comparison of current asthmatics with and without work-relatedness, measures of control, NAS-NYS 2002–2003, and NYS ACBS 2006, 2007.

	NAS-NYS			ACBS		
	WRA% <i>N</i> = 445	Non-WRA% <i>N</i> = 569	<i>p</i> value	WRA% <i>N</i> = 245	Non-WRA% <i>N</i> = 316	<i>p</i> value
Overall control						
Well controlled	26.3	15.3	.0009	10.0	33.0	<.0001
Not well/poorly controlled	73.7	84.7		90.0	67.0	
Use of short-acting beta agonists						
During the past 3 months	70.0	71.0	.8	54.5	75.1	.0007
Less than daily	30.0	29.0		45.5	24.9	
Daily/several per day						
Symptoms during the past 30 days	48.3	60.4	.009	39.8	57.7	.002
Less than daily	51.7	39.6		60.2	42.3	
Daily/several per day						
Activity limitations during the past twelve months						
None/minor	25.8	40.1	.0005	18.0	44.5	<.0001
Moderate/a lot	74.2	59.9		82.0	55.5	
Nighttime awakenings during the past 30 days						
Less than 3 times	73.6	82.9	.02	62.5	85.2	<.0001
3 times or more	26.4	17.1		37.5	14.8	

Note. All percentages are weighted.

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Table 7.—Industry classification of WRA cases, NYS Occupational Lung Disease Registry 2002–2007 and Employed Adults in NYS.

Industry description (NAICS categories)	OLDR cases% ^a	NYS employed adults% ^b
Educational, Health, and Social Services (61–62)	20.1	25.1
Manufacturing (31–33)	16.7	8.1
Public Administration (92)	10.7	4.7
Construction (23)	6.8	6.8
Professional, Scientific, Technical, and Administrative (54–56)	6.4	10.7
Transportation, Warehousing, and Utilities (22, 48–49)	5.6	5.6
Wholesale and Retail Trade (42–45)	5.2	13.5
Information, Finance, Insurance, and Real Estate (51–53)	4.5	11.6
Other Services (81)	4.3	5.1
Agriculture and Related (11, 21)	2.9	0.6
Leisure Services (71–72)	1.9	8.2

^aDue to missing values, percentages may not add up to 100.

^bAggregate averages of employment data from the Current Population Survey, includes persons older than 18 years of age from 2002–2007.

Respondents identifying as non-White ranged from 30.2% from the ACBS to 42.6% in BRFSS. Differences in education and household income were also seen.

Defining control using the NAEP EPR-3 guidelines, respondents with WRA from the ACBS and NAS-NYS had significantly less well-controlled asthma than respondents with non-WRA (Table 6). This difference was observed for three out of the four components used to classify control from the NAS-NYS and for all four from the ACBS (Table 6). Significantly more adults with WRA had symptoms at least daily, had more activity limitations, and were awakened at night three times or more a month. Significantly more of those with WRA from the ACBS used inhaled asthma medications daily or more than those without WRA.

OLDR Data

From 2002 to 2007, there were 1075 individual cases of WRA reported to the OLDR that were included in this analysis. The majority were 45 years of age or older, which is similar to the WRA population from BRFSS but different from those with WRA from the NAS-NYS and ACBS (data not shown). There was no difference in gender in the OLDR, whereas the majority of respondents with WRA from the population surveys were female. The majority of OLDR cases were White (71.3%), which was significantly different from those with WRA from BRFSS (57.4%). Geographic distribution was similar for those with WRA from all data sources, with the majority living outside of NYC.

Occupation at the time of diagnosis was reported to the OLDR. The five most common occupations of WRA cases included machine operators (15.7%), office administrators and support staff (10.7%), construction and related trades (9.4%), health care workers (5.4%), and building cleaning and maintenance services (5.3%) (data not shown).

The most frequently reported industries of employment were educational, health and social services (20.1%), followed by manufacturing (16.7%) and public administration (10.7%) (Table 7). Significantly fewer OLDR cases were employed among the wholesale/retail trade and leisure service industries as compared to the NYS employed adult population. Although not significant, slightly more manufacturing and public administration industries were represented among OLDR cases.

Up to three potential exposures were recorded for each WRA report. The most common exposures were dusts

(31.7%), indoor air quality (13.7%), and solvents (8.7%) (data not shown). Most exposures were found in all industries and occupations. However, cases employed in the manufacturing industry were exposed to metals and metal fumes as well as hydrocarbons, including solvents and cutting oils, significantly more often than in other industries. Exposures affecting indoor air quality, including mold, were reported significantly more often in the educational, health and social services, and public administration industries when compared to other industries. Cases employed within the service industries were exposed to cleaning materials significantly more often than other industries.

DISCUSSION

The percentage of current asthma associated with work ranged from 10.6% (BRFSS) to 44.5% (ACBS). The ACBS had the broadest definition of WRA and included questions about causation and aggravation in both current and previous jobs, which may explain the high percentage of asthma associated with work. The NAS-NYS question was similar to the combined ACBS questions and produced similar estimates. However, in BRFSS, a definition of WRA was contingent upon the person having a discussion of WRA with a health professional. The BRFSS definition would not capture the people who may have problems with their asthma at work but did not discuss work-relatedness with their health professional, which may be as many as 62% of the people who experienced a work-related problem according to the ACBS.

Although population-based surveys may be more useful in estimating the number of people with WRA, they are not without their own limitations. Population surveys rely on self-report of asthma, symptoms, and temporal association to workplace exposures. There is no objective evidence of work-relatedness and no detailed information is collected on exposures or workplace practices. There is also the possibility that questions may be misinterpreted in the population-based surveys. For instance, in the ACBS, of those who reported asthma caused by a current or previous job, 42% had an age of onset less than 18. Most likely, respondents only considered what triggered the symptoms or asthma attacks when answering these questions, not the cause of the disease. In addition, these are telephone surveys of residential households; therefore those without a land-line telephone (no telephone or cell phone only) are not represented in the sample. The surveys are also conducted in English and Spanish; therefore,

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they do not cover the various languages spoken in the United States.

In the population-based surveys, those with WRA reported more adverse effects than those with non-WRA. Those with WRA reported not only less well controlled asthma but were also more likely to have a lower income and be unemployed due to health problems or disability. It is unknown which comes first, if the decreased control makes them more susceptible to workplace exposures, or if the WRA makes the asthma more difficult to control. The poor control over asthma can result in additional costs to both the worker and employer for health care and time lost. A study of patients from the NYS Occupational Health Clinic Network (OHCN) showed that 45% of those with WRA changed jobs due to workplace exposures (8). Adults with work-related asthma have reported many adverse outcomes from various studies, including increased hospitalizations, reduced income, loss of employment, difficulty getting employment, leaving employment due to exposures, and having ongoing occupational exposures (9–11).

WRA often goes undiagnosed, which is in part due to health professionals not having the ability or willingness to recognize and document the workplace exposures contributing to asthma (24, 25). One study showed that health professionals often overlook or fail to note any possibility of an occupational exposure, only documenting work-relatedness in less than 10% of patients with asthma (26). In the ACBS survey, only 37.9% of adults with current asthma who self-reported an association of asthma with work had a discussion with a health professional about WRA. Diagnosing WRA requires a systematic and potentially time-consuming process to determine the work-relatedness (6). This includes not only routine medical tests, but also objective work histories and questions to derive a temporal association between asthma symptoms and work exposures. As a result, primary care physicians may refer their patients to secondary care facilities for assessment and treatment, a practice that may hinder a timely diagnosis of WRA. In a study of patients in the United Kingdom, an average of 4 years lapsed between when a patient was first seen and when they were seen in a secondary care facility for assessment of possible occupational lung disease (27). The study of WRA patients from the NYS OHCN showed that 84% were already taking asthma medication at the time of their first visit to a specialized provider, and 75% were referred to the clinic by an outside source, indicating that the patient population was already seeking care for their asthma symptoms prior to being seen in the clinics (8). Although the process of diagnosis and management of WRA can be difficult and time consuming, there is an increasing amount of literature available to physicians to provide guidance (6). It is important for every physician who encounters an adult patient with new-onset asthma or worsening of pre-existing asthma to consider the possibility of WRA.

After WRA is diagnosed, it is imperative that it is reported to occupational health surveillance systems. In NYS, the OLDR relies on physicians and health facilities to not only recognize that a patient's asthma is work-related but also to report it to the registry. However, like many other diseases, underreporting of WRA to public health agencies is widespread and systems that rely on health professionals to report underrepresent the true population (24). These

differences in the population-based surveillance estimates and the number of cases reported to the OLDR attest to this. However, information gained from the OLDR and other case-based surveillance systems, although possibly not an accurate indication of the number of individuals with WRA, is useful to help guide public health prevention and intervention activities. The distribution of industry in the OLDR is similar to that found in the NYS OHCN and other state-based surveillance systems (3, 8, 28). Manufacturing and service industries, particularly health and education, are frequently reported high-risk industries (3, 8, 28). Also, dust and poor indoor air quality were the most frequently reported work exposures in the OLDR, which is similar to other surveillance studies (3, 8, 28). Although both agents affected all occupations and industries, they were most prominent among those working in education, health care, and administration industries. These work environments are primarily indoors (schools, hospitals, office buildings), supporting evidence that more research needs to be conducted on improving air quality in buildings (29).

CONCLUSION

It is estimated that WRA costs over \$1.5 billion in direct and indirect costs, placing a large burden on health care, businesses, and the economy (6). According to the ACBS, 45% of adults with current asthma can associate their asthma with work, which puts millions of workers at risk. High-risk industries can be targeted for intervention, as well as further education to health professionals and the general public. If recognized and treated early, the adverse health and socioeconomic effects associated with WRA can be prevented.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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