ORIGINAL ARTICLE

Characteristics of work related asthma: results from a population based survey

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Objectives: Many risk factors for asthma have been investigated, one of which is the workplace. Work related asthma is a frequently reported occupational respiratory disease yet the characteristics which distinguish it from non-work related asthma are not well understood. The purpose of this study was to examine differences between work related and non-work related asthma with respect to healthcare use and asthma control characteristics.

Methods: Data from the Massachusetts Behavioral Risk Factor Surveillance System for 2001 and 2002 were used for this analysis. Work related status of asthma was determined by self-report of ever having been told by a physician that asthma was work related. Healthcare measures evaluated were emergency room visits and physician visits for worsening asthma and for routine care. Characteristics of asthma control evaluated were frequency of asthma symptoms, asthma attacks, difficulty sleeping, and asthma medication usage in the last 30 days and limited activity in the past 12 months.

Results: The prevalence of lifetime and current asthma in Massachusetts were 13.0% and 9.2%, respectively. Approximately 6.0% (95% CI 4.8 to 7.3) of lifetime and 6.2% (95% CI 4.7 to 7.8) of current asthma cases were work related. In the past 12 months, individuals with work related current asthma were 4.8 times (95% CI 2.0 to 11.6) as likely to report having an asthma attack, 4.8 times (95% CI 1.8 to 13.1) as likely to visit the emergency room at least once, and 2.5 times (95% CI 1.1 to 6.0) as likely to visit the doctor at least once for worsening asthma compared to individuals with non-work related asthma.

Conclusions: Work related asthma is associated with increased frequency of asthma attacks and use of healthcare services. A better understanding of factors that contribute to differences in healthcare use and asthma control is needed to improve prevention and control strategies for individuals suffering from the disease.

Asthma poses a large public health burden in the United States. In 2002, an estimated 16 million (7.5%) adults reported ever having asthma.¹ Asthma negatively impacts quality of life, accounting for thousands of deaths, hundreds of thousands of hospitalisations, nearly two million emergency department visits, and 10 million physician office visits in any given year in the US.^{2–4} Risk factors for adult onset asthma include female gender, lower socioeconomic status, obesity, smoking status, airway hyperresponsiveness, and other lifestyle factors.^{5–6}

Workplace exposures may also contribute to the induction or exacerbation of asthma. Several reviews have summarised the workplace contribution to asthma.^{7–9} The American Thoracic Society (ATS) suggested an estimate of 15% as the occupational contribution to adult asthma.¹⁰ More than 250 workplace agents have been identified as causes of asthma and work related asthma is a frequently reported occupational respiratory disease.¹¹ Therefore, estimating the proportion of asthma related to work has important public health implications and can provide guidance in future prevention and control efforts.

Population based comparisons of differences in disease burden between work related and non-work related asthma cases are sparse. The few existing studies suggest that individuals with work related asthma often change or suffer disruptions to their jobs and have greater difficulty finding new work.^{12–14} Risk of hospitalisation has also been evaluated although the evidence is inconclusive.^{15–16}

In this study, we investigated the differences between work related and non-work related current asthma with respect to two aspects of disease burden: healthcare use and asthma control. Specifically, we measured the association

between work related asthma status and the number of emergency room visits, the number of physician visits for worsening asthma, and the number of visits for routine check-ups. We investigated differences in asthma control measures such as frequency of asthma symptoms, number of asthma attacks in the past year, medication usage, sleeping difficulty, and inhibition of usual activity. We also report the proportions of lifetime and current asthma in Massachusetts that were work related.

METHODS

The present analyses are based on data collected as part of the 2001 and 2002 Massachusetts Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is an annual ongoing random digit dial statewide telephone survey of approximately 8000 adult Massachusetts residents 18 years or older which collects information on risk factors for disease and injury, chronic conditions, preventive health behaviours, and emerging public health issues. The survey is conducted jointly by state health departments and the Centers for Disease Control and Prevention (CDC). Phone numbers are randomly selected throughout the state, excluding business and non-working numbers. Once contact with a household is made, one individual from that household is randomly selected for an interview. Characteristics of the BRFSS are described in detail elsewhere.¹⁷ The BRFSS has been designated as ongoing public health surveillance rather than human subject research; it is exempt from the human subjects review.

Abbreviations: ATS, American Thoracic Society; CDC, Centers for Disease Control; BRFSS, Behavioral Risk Factor Surveillance System.

Table 1 BRFSS 2002 adult asthma questions

How old were you when you were first told by a doctor, nurse, or other health professional that you had asthma?

During the past 12 months, have you had an episode of asthma or an asthma attack?

During the past 12 months, how many times did you visit an emergency room or urgent care centre because of your asthma?

During the past 12 months, how many times did you see a doctor, nurse, or other health professional for urgent treatment of worsening asthma symptoms?

During the past 12 months, how many times did you see a doctor or other health professional for a routine check-up for your asthma?

Symptoms of asthma include cough, wheezing, shortness of breath, chest tightness, and phlegm production when you don't have a cold or respiratory infection. During the past 30 days, how often did you have any symptoms of asthma?

During the past 30 days, how many days did symptoms of asthma make it difficult for you to stay asleep?

During the past 30 days how often did you take asthma medication that was prescribed or given to you by your doctor? This includes using an inhaler.

During the past 12 months, how many days were you unable to work or carry out your usual activities because of your asthma?

Definitions of variables

In both 2001 and 2002, the survey included two questions regarding asthma. Lifetime asthma was determined by an affirmative answer to the question, "Have you ever been told by a doctor, nurse, or other health professional that you have asthma?" If respondents also answered "yes" to the question "Do you still have asthma?" they were considered to have current asthma.

Each year, programmes within the Massachusetts Department of Health nominate supplemental modules for inclusion in the BRFSS. In 2001 and 2002, a work related asthma module was included which asked the following two questions: "Were you ever told by a doctor or other medical person that your asthma was related to any job you ever had?" and "Did you ever tell a doctor or other medical person that your asthma was related to any job you ever had?" While both questions attempt to establish an association between work and asthma, the first is considered more conservative and is based on self-report of a physician diagnosis. Thus, for the present study, an asthma case was defined as work

related only if an individual responded "yes" to the first question.

In addition, an adult asthma module was included in 2002, which contained a more extensive set of questions on measurements of asthma control and healthcare use (table 1). These included age of asthma onset, asthma attacks, emergency room visits, physician visits for worsening asthma, physician visits for routine care, and limited activity in the past 12 months, symptoms of asthma, difficulty sleeping, and asthma medication usage in the last 30 days.

Statistical analysis

Prevalence of lifetime and current asthma and the proportions of lifetime and current asthma that were work related are presented for the years 2001–02. Comparisons of differences in healthcare use and asthma control between work related and non-work related individuals were restricted to current asthma reported in 2002 only.

Differences in sociodemographic characteristics between participants with work related and non-work related asthma were tested using the χ^2 test. Data on potential confounders were also assessed via the questionnaire. All point estimates from logistic regression models were a priori adjusted for age, gender, race, and education. Obesity and smoking status were evaluated in the statistical models for potential confounding. Smoking status was dropped, because it had no effect on the point estimates. Obesity was retained because most point estimates changed by more than 10% upon inclusion. Odds ratios and 95% confidence intervals for the effects of work related asthma on healthcare use and asthma control measures were computed using multiple logistic regression. The BRFSS was weighted to account for the probability of sample selection and differential participation based on age, gender, and race. All the analyses were conducted using the SUDAAN 9.0.0 statistical software package (Research Triangle Institute, Research Triangle Park, NC, USA), which provided calculation of robust variances and weighted analyses.¹⁸

RESULTS

In 2001 and 2002, 16 057 individuals were interviewed regarding their asthma status (8628 in 2001; 7429 in 2002) as

Table 2 Prevalence of lifetime (n = 16 031) and current (n = 15 987) asthma in Massachusetts adults by age at onset and gender, 2001–02

	Prevalence (weighted %)	95% CI
Lifetime asthma prevalence	13.0	12.3–13.6
Men	11.1	10.2–12.0
Women	14.6	13.7–15.5
Childhood onset*,†	3.7	3.3–4.1
Men	3.4	2.9–4.0
Women	3.9	3.3–4.4
Adult onset†	6.1	5.7–6.6
Men	4.2	3.6–4.7
Women	7.9	7.2–8.5
Current asthma prevalence	9.2	8.6–9.8
Men	7.3	6.5–8.2
Women	10.8	10.0–11.7
Childhood onset*†	2.3	2.0–2.6
Men	1.8	1.3–2.2
Women	2.8	2.3–3.3
Adult onset†	4.8	4.4–5.2
Men	3.3	2.8–3.9
Women	6.2	5.6–6.8

*Defined as <16 years of age at time of asthma diagnosis.

†Childhood onset prevalence and adult onset prevalence do not add up to the total prevalence due to non-response to the asthma onset questions.

Table 3 Sociodemographic characteristics of Massachusetts adults with lifetime asthma: work related (WR) versus non-work related, 2001–02

	WR asthma (weighted %)	Non-WR asthma (weighted %)	p Value
Characteristic			
Gender	(n = 133)	(n = 1874)	0.968
Male	39.4	39.6	
Female	60.7	60.4	
Age group (years)	(n = 133)	(n = 1853)	0.072
18–44	49.7	59.9	
45+	50.3	40.1	
Race*	(n = 132)	(n = 1854)	0.055
White	76.5	85.8	
Other	23.5	14.2	
Education level	(n = 133)	(n = 1874)	0.670
≤ High school	32.8	35	
≥ 1 years of college	67.2	65	
Ever smoked	(n = 133)	(n = 1868)	0.085
Never	52.2	50.5	
Former	34.8	29.3	
Current	13.0	20.2	
Employed	(n = 133)	(n = 1871)	0.440
yes	57.2	61.8	

*"White" includes non-Hispanic whites and "other" includes Hispanics, Asians, Blacks, American Indians, Pacific Islanders, and those who classified themselves as "other".

Table 4 Association of work related asthma with frequency of healthcare use and measures of asthma control, 2002

	Characteristic present (%)	Crude OR	95% CI	Adjusted OR*	95% CI
Asthma attack in the past 12 months					
Non-work related (n=559)	53.1	1.0		1.0	
Work related (n=48)	79.9	3.5	1.5–8.0	4.8	2.0–11.6
More than one visit to the emergency room in the past 12 months					
Non-work related (n=561)	13.2	1.0		1.0	
Work related (n=48)	31.3	3.0	1.2–7.7	4.8	1.8–13.1
More than one visit to the doctor for worsening asthma					
Non-work related (n=559)	21.4	1.0		1.0	
Work related (n=47)	36.6	2.1	0.9–4.8	2.5	1.1–6.0
More than one visit to the doctor for routine asthma					
Non-work related (n=560)	53.4	1.0		1.0	
Work related (n=47)	71.6	2.2	1.0–4.8	2.2	0.9–5.3
Asthma symptoms in the past month					
Non-work related (n=552)	66.3	1.0		1.0	
Work related (n=47)	75.1	1.5	0.6–3.9	1.6	0.6–4.6
Difficulty sleeping in the past month					
Non-work related (n=373)	43.5	1.0		1.0	
Work related (n=37)	61.7	2.1	0.9–5.0	2.0	0.8–5.5
Asthma medication use in the past month					
Non-work related (n=562)	67.3	1.0		1.0	
Work related (n=47)	72.6	1.3	0.5–3.1	1.6	0.6–4.4
Inability to carry out usual activities in the past 12 months					
Non-work related (n=544)	22.2	1.0		1.0	
Work related (n=47)	21.7	1.0	0.5–2.1	1.3	0.6–3.3

*Adjusted for dichotomous age (18–45, 45+), race (white v other), gender, education (high school v college), and obesity (not obese, overweight, obese).

part of the BRFSS annual survey. The response rate for the Massachusetts BRFSS was 40% in 2001 and 66% in 2002. These response rates cannot be directly compared to each other, however, because the BRFSS changed its coding practice in 2002 in order to more accurately differentiate between different types of response and non-response and to bring the BRFSS coding system more in line with recommendations from the American Association for Public Opinion Research. The change in coding allowed for more accurate accounting of participation rates, such as response rates (personal communication, Dr Michael Link, CDC, 2005).

Lifetime and current asthma prevalence

After excluding 26 individuals with missing data for asthma status, 2112 individuals reported ever having been told by a physician they had asthma. The prevalence of lifetime and current asthma for the two years combined were 13.0% and 9.2%, respectively (table 2). Adult onset of asthma was twice as prevalent as childhood onset for both lifetime and current asthma. Women were more likely than men to report having lifetime and current asthma, and this was largely driven by a greater proportion of women with adult onset asthma.

Proportion of asthma related to work

Among individuals with lifetime asthma, 2007 responded to the question about whether their asthma was work related. Cases of work related and non-work related asthma were similar with respect to age, gender, smoking status, education, and employment status (table 3). However, a greater proportion of individuals with work related asthma were non-white compared to those with non-work related asthma. Six per cent (95% CI 4.8 to 7.3) of lifetime asthma cases ever reported being diagnosed with work related asthma. Similarly, among the 1427 individuals who reported current asthma at the time of questionnaire administration, 6.2% (95% CI 4.7 to 7.8) reported ever being told their asthma was associated with work. The proportion of the population with adult onset asthma whose asthma was related to work was

twice as large as the proportion with childhood onset asthma related to work (data not shown).

Differences between work related and non-work related current asthma

Analyses of healthcare use and asthma control measures were conducted for individuals with current asthma using 2002 data, the only year for which these data were available. In 2002, 870 participants reported whether their current asthma was work related. Because of missing values in the variables age, race, gender, education, and obesity, the sample size was further reduced to approximately 600 individuals in models which adjusted for these variables. Work related asthma was associated with increased odds ratios for all of the characteristics evaluated, although not all associations met statistical significance (table 4).

Individuals with work related asthma were 4.8 times (95% CI 2.0 to 11.6) as likely to report having an asthma attack in the past 12 months, 4.8 times (95% CI 1.8 to 13.1) as likely to visit the emergency room at least once in the past 12 months, and 2.5 times (95% CI 1.1 to 6.0) as likely to visit the doctor at least once for worsening asthma compared to individuals with non-work related asthma. The covariates most responsible for the observed increases in adjusted odds ratios compared to crude estimates for asthma attacks and visits to the emergency room were obesity, followed by race and education. Thus, obesity, race and education may be important confounders to consider for further investigations into differences between work related and non-work related asthma with respect to healthcare use and asthma control measures.

When asked about frequency of asthma symptoms such as cough, wheezing, shortness of breath, chest tightness, and phlegm production within the past 30 days, an increased but non-significant odds ratio was observed between work related and non-work related asthma cases. Similarly, increased but non-significant associations were found for number of visits to the doctor for a routine check-up related to asthma, difficulty sleeping, frequency of asthma medication

use, and inability to carry out usual activities in the past 12 months.

DISCUSSION

In this study, data from the Massachusetts BRFSS were analysed to determine whether differences in work related and non-work related asthma exist with respect to healthcare use and measures of asthma control. Overall, we found the prevalence of lifetime and current asthma in Massachusetts for 2001–02 to be 13.0% and 9.2%, respectively. Lifetime asthma prevalence for Massachusetts was higher than the BRFSS national average (11.0%) and the national average reported by the National Center for Health Statistics (10.8%) for the years 2000–02.^{4–19} Women were also more likely than men to report having lifetime and current asthma, an observation consistent with other data.²⁰ The proportion of work related asthma was 6.0% among those reporting lifetime asthma and 6.2% among those reporting current asthma. These estimates are consistent with those reported from BRFSS data for California and Michigan in 2001 (personal communication, Jennifer Flattery, 2005) and other large population based studies.^{21–22} These estimates are lower than the ATS estimate of 15% of asthma attributable to work and, in general, are at the low end of the range reported in previous reviews.^{7–10, 23}

Individuals with work related asthma were significantly more likely to experience asthma attacks, emergency room visits, and visits to the doctor in the past 12 months due to worsening asthma. One explanation for these associations is that greater use of healthcare services for non-routine visits may indicate poor control of asthma. Although a significant difference in reporting of recent asthma symptoms was not concurrently found, the observed associations indicate that a problem exists.

Studies have demonstrated that questionnaire based indices of asthma control and/or health related quality of life can predict acute and routine healthcare use such as inpatient care, emergency room visits, and physician visits.^{24–26} Vollmer *et al*, for instance, found that as the number of control problems increased, increasing percentages of patients reported making visits to the doctor, emergency room or urgent care, or inpatient hospital stays for asthma in the past year.²⁵ It may be that individuals with work related asthma are exposed more frequently to triggers. Workplace triggers may be more episodic than other triggers, making asthma control more difficult for these individuals, or individuals do not receive needed protection and information regarding workplace exposures. Another possibility is that the distribution of asthma subtypes (for example, Reactive Airway Dysfunction Syndrome, IgE mediated sensitisation) differs between work related and non-work related asthma cases. Thus, the observed association could be partially due to a greater number of individuals with work related asthma with a subtype of asthma more difficult to control or associated with more frequent healthcare use.

Alternatively, individuals with work related asthma may have greater access to healthcare services. This is unlikely in the current study, however, because the percentage of individuals with asthma who were covered by health insurance did not differ nor did the types of insurance differ between work related and non-work related cases (data not shown).

Given the observed associations with asthma attacks, emergency room visits, and non-routine visits to the doctor, it was surprising to see no strong association with frequency of asthma symptoms. While the odds ratio was increased (1.7) and suggestive of an association, the confidence interval was wide (0.6–4.7). One reason for this may be the shorter time frame over which the questions were asked. Individuals

were asked to recall presence of symptoms in the past 30 days, whereas asthma attacks and physician visits were assessed over a one year period. Thus, the BRFSS questionnaire may be better suited for capturing chronic asthma control and healthcare use differences.

To date, few studies have evaluated differences in work related versus non-work related asthma. Among those that have, different parameters have been evaluated, making direct comparisons difficult. Vandenplas *et al* found no difference in rates of hospitalisation for respiratory disease and mortality between subjects with and without occupational asthma using data from the Ontario Workers Compensation Board in Canada.¹⁵ In contrast, we found significantly increased odds ratios for outpatient services such as number of emergency room visits and doctor visits. Outpatient visits are likely a more sensitive measure of poor asthma control than hospitalisations. Poor control of the disease or continuing exposure to the trigger may prompt more acute outpatient visits, but the health problems may not be severe enough to warrant subsequent admission to the hospital.

In this study, we compared individuals with current asthma who had ever been diagnosed with work related asthma to those who had not. However, we do not know the specific timing of the work related diagnosis. For example, among individuals with a diagnosis of work related asthma 10 years ago, some may be experiencing current symptoms not related to work while others may have removed themselves from workplace triggers and no longer experience symptoms. If the first group of individuals would not be diagnosed today as having work related asthma, our observed association may be overestimated. Alternatively, if the latter group of individuals would not be diagnosed today as having work related asthma, our observed association may be underestimated.

The prevalence of work related asthma is difficult to accurately assess, in part, due to underrecognition as well as underreporting by physicians. In two different HMO based studies of adult onset asthma in which medical records were reviewed, a discussion of work exposures in relation to asthma diagnosis appeared in the charts in only 7% and 15% of the cases, respectively.^{27–28} In light of this underrecognition, work related asthma may often be misclassified as non-work related. Many factors may contribute to whether a physician believes the asthma is work related, including, for example, knowledge of triggers and the patient's profession. This misclassification may be differential with respect to the outcomes in this study if a history of frequent healthcare use or a greater number of asthma attacks makes it more likely that the doctor will correctly identify a work related exposure as the source of disease, whereas individuals with infrequent healthcare use or few asthma attacks remain misclassified as non-work related. Such misclassification would yield an inflated odds ratio and could partially explain our results. If true, this would imply the true prevalence of work related asthma is much greater than current estimates, which is also an important public health concern.

Interpretation and generalisation of the present study results are subject to a number of limitations. Given the cross sectional nature of the BRFSS design, causal inference regarding the associations of work related asthma and the healthcare measures is limited. The BRFSS excludes institutionalised individuals, individuals younger than 18 years of age, and respondents with no landline telephones. Thus, for Massachusetts, generalisability to these subpopulations is limited. Information about other potential risk factors for the evaluated healthcare measures, such as atopy, airway hyperresponsiveness, physical exercise, family history of asthma, and other chronic respiratory illness, were not available. Also, the validity of self-reported asthma in the

Main messages

- Based on self-report of physician diagnosed work related asthma, 6.2% of current asthma and 6.0% of lifetime asthma in Massachusetts adults is related to the workplace.
- Differences between work related and non-work related asthma exist; work related asthma is associated with increased frequency of asthma attacks, emergency room visits, and visits to the physician for worsening asthma.

Policy implications

- Recognising the contribution of work related asthma to the overall asthma burden is necessary to develop a comprehensive approach to asthma prevention and control.
- Understanding the factors that contribute to differences in healthcare use and asthma control is necessary to design effective interventions for work related asthma.

BRFSS is unknown. However, other studies have suggested good agreement between self-reported asthma and medical records, with sensitivity and specificity comparing self-reported asthma to clinical diagnoses of 68% and 99%, respectively.^{29–31}

Lastly, the Massachusetts response rates were low, which could bias the results if the non-response is not random. In this case, non-responders would have to differ from responders with respect to work related status of their asthma and to each of the measures evaluated to introduce bias. While data on non-responders are limited, Zhang *et al* compared the 2000 BRFSS sample to the 2000 US Census data for Massachusetts and concluded that the BRFSS sample reflected its target population in most demographic and socioeconomic variables despite its low response rate.³²

In summary, our analysis of a large population based survey of Massachusetts adults found the proportion of work related asthma among individuals with current asthma in 2002 was 6.2% and with lifetime asthma was 6.0%. These proportions are likely to be underestimated, since physician diagnosed work related asthma, as defined in the present study, is a conservative definition of work related asthma. Work related asthma may be associated with poor asthma control that results in increased frequency of asthma attacks, emergency room visits, and physician visits. These results illustrate a need for a better understanding of the factors that contribute to differences in healthcare use and asthma control in order to design effective interventions for work related asthma.

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