Work-exacerbated asthma

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Purpose of review

To summarize recent findings on work-exacerbated asthma, based on medical literature published during 2005 and the first 10 months of 2006.

Recent findings

Although prevalence estimates varied considerably among six recent epidemiologic studies, collectively they contribute to the conclusion that work-exacerbated asthma is common. Median work-exacerbated asthma prevalence estimates were 18% of adults with asthma, 25% of working adults with asthma and 45% of all work-related asthma cases. Work-exacerbated asthma can result from a variety of occupational triggers, including physical factors (e.g. extreme temperatures, exercise), behavioral states (e.g. strong emotions, stress), odors (e.g. perfume), general irritants and dust, and second-hand cigarette smoke. Work-exacerbated asthma cases have many of the same demographic and clinical traits as other adults with asthma and occupational asthma cases, although some differences have been reported. Recent review articles have offered some recommendations on the management of work-exacerbated asthma, but more comprehensive advice is anticipated from a professional medical society in the next few years.

Summary

Epidemiologic studies indicate that work-exacerbated asthma is common. Researchers have started to pay attention to work-exacerbated asthma, but more studies are needed on all aspects of this condition in order to improve diagnosis, management and prevention.

Keywords

asthma, exacerbation, occupational diseases, occupational exposures

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Abbreviations

ATS	American Thoracic Society
WEA	work-exacerbated asthma

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Introduction

There is general agreement among recent review articles that work-related asthma comprises both asthma caused by conditions at work and asthma exacerbated by work [1–4]. Occupational asthma is caused by work and can result from exposure to either sensitizers or irritants. Irritant occupational asthma includes reactive airways dysfunction syndrome, which is due to a single high-dose irritant exposure. Work-exacerbated asthma (WEA) is the worsening of asthma attributable to workplace conditions. It occurs among people with asthma whose onset occurred before entering the suspected job (i.e. preexisting asthma) or while in the suspected job, but with onset not attributable to workplace conditions (i.e. coincident or concurrent asthma). A recent statement [5] of the American Thoracic Society (ATS) concluded that 15% of asthma in adults is attributable to work. The authors of the ATS statement [5] also made the observation that WEA may account for 'much greater morbidity and productivity loss' than occupational asthma.

Many researchers have focused either on all work-related asthma (i.e. occupational asthma and WEA combined) or exclusively on occupational asthma. Fortunately, more researchers have started to focus on WEA. The third edition of a book [6••] on work-related asthma was published in 2006 and included a chapter on WEA that summarized many of the relevant papers and reports that were published before 2005. The current review summarizes findings about WEA from medical literature published in 2005 and January through October in 2006.

Search strategy

The Ovid portal to Medline was used to search for relevant articles published in 2005 and the first 10 months of 2006, using both the regular listings for these years and those included in 'In-Process and Other Nonindexed Citations'. The keywords used to search all fields were: asthma and (exacerbate or aggravate) and (work related or occupation). Variations of the words (e.g. exacerbate, exacerbation, exacerbating) were also considered. This effort yielded 33 unique citations, of which seven were

used in this review after articles with little or no relevance to WEA were excluded. Additional references were sought from abstracts presented at the 2005 and 2006 conferences of the ATS and the European Respiratory Society. One referenced article appeared in 2005, but was back-dated to 2003 because the journal was filling in missed editions after a temporary suspension of publication [7]. Finally, additional references were accessed based on the author's familiarity with the literature.

Operational definitions and estimates of prevalence

Characteristics of six recent epidemiologic studies on WEA are presented in Table 1. The studies differed by several features, including location (i.e. Brazil, Quebec province in Canada and four states in the United States) and study setting (i.e. population-based, health maintenance organization, medical center, referral clinic and workers' compensation system). Four studies used data from questionnaires and medical records [8,9•–11•], and one of these four also employed clinical tests conducted by the researchers [11•]. A fifth study used both a questionnaire and clinical tests [12••], and only one relied exclusively on questionnaire data [7]. All the operational definitions of WEA were based, in part, on reports by participants that conditions at work made their asthma worse or that their asthma improved while away from work. Each study, however, used different questions to elicit these reports.

Two of the operational definitions included consideration of conditions at work that could exacerbate asthma. One of these two studies used an epidemiologic approach to exposure assessment and the other used a clinical test to explore the exposure–response relationship. In the study conducted in an health maintenance organization in Massachusetts, the researchers evaluated the participants' work histories to determine who was likely to have been exposed to conditions at work that could exacerbate asthma and assigned a score of 0, 1 or 2, which represented increasing likelihoods of exposure [10•]. Each participant also had a work-related symptom score of 0, 1, 2 or 3, based on their responses to questions about work-related symptoms and medication use, and asthma triggers at work. Participants with a symptom score of 3, which was true of only 26 (5%) of the 557 employed subjects, were classified as having WEA regardless of their exposure score, but all others had to have both their exposure and symptom scores greater than 0 to fulfill the criteria for WEA. Subjects in the study from Quebec were patients with asthma (but not reactive airways dysfunction syndrome cases) who had experienced work-related respiratory symptoms and been referred for specialized evaluation [11•]. Patients were directly evaluated with a specific inhalation challenge test, and those with negative results were classified as WEA cases and those with positive results were classified as occupational asthma cases.

Consistent with the differences among studies, WEA prevalence estimates varied considerably: from 13 to 23% (median = 18%) among adults with asthma and from 24 to 52% (median = 25%) among working adults with asthma. Variation in prevalence estimates was also observed among studies that predate the time period addressed by this review [6••], although none of the previous estimates was as high as the 52% of working adults with asthma reported from New York City [8].

Three studies summarized in Table 1 reported the number of WEA cases as a percentage of all work-related asthma cases. In order to have the denominator needed to calculate this percentage, the researchers had to identify both occupational asthma and WEA cases. The population-based study in Brazil tested nearly all subjects for bronchial hyperresponsiveness, but decisions about work-related asthma were based largely on self-reported information [12••]. The study of workers' compensation cases from the state of Washington used objective tests infrequently [9•]. Among the 135 WEA cases, only 15% were tested for reversible airflow limitation, 31% had that test or other pulmonary function tests and 9% completed tests for allergic sensitization. Clinical history played an important role in helping the researchers decide whether someone with asthma had occupational asthma, WEA or neither. Nearly all suspected cases of work-related asthma seen at the referral clinic in Quebec completed specific inhalation challenge tests, with the outcomes used to separate occupational asthma and WEA cases [11•]. The diverse efforts in the three studies yielded a range of estimates of the percentage of all work-related asthma cases that are WEA: 36% in Brazil [12••], 45% in Washington state [9•] and 58% in Quebec [11•].

The estimate from Washington is more than twice as large as the finding from Sentinel Event Notification Systems for Occupational Risks surveillance data collected during 1993–1995 in four states (i.e. California, Massachusetts, Michigan, and New Jersey) in the United States, when only 19% of the work-related asthma cases were due to exacerbation [13,14]. The state-specific estimates from these earlier Sentinel Event Notification Systems for Occupational Risks data were 10% for Michigan, 13% for Massachusetts and New Jersey, and 34% for California. The higher estimate from this recent study in Washington might be due in part to increased recognition by physicians of the risk for exacerbation of asthma posed by work. The estimate from Quebec that 58% of work-related asthma cases are WEA is consistent with prior estimates from the Canadian province of Ontario [15,16].

Table 1 Epidemiologic and clinical studies of work exacerbated asthma

Setting	Study location	Source of data	Asthma criteria	Timing of WEA	WEA criteria	Percentage of WEA (denominator)		
						In adults with asthma	In working adults with asthma	In all work-related asthma cases
Population	State of Maine, USA [7]	Questionnaire	Current physician diagnosis of asthma or symptoms consistent with asthma	Past 12 months	Coughing or wheezing worse at work	18% (88)	25% (64)	NA
	Brazil [12••]	Questionnaire, clinical tests conducted by researchers	Asthma symptoms in past 12 months and positive bronchial hyperresponsiveness	Any job	Preexisting asthma worsened by workplace exposure	13% (227)	NA	36% (81)
Health maintenance organization	State of Massachusetts, USA [10•]	Questionnaire, medical records	Physician diagnosis of asthma, asthma active in past 12 months and onset 14 months or more before interview	Past 12 months	(1) Work-related asthma symptoms, medication use or triggers; (2) Researchers reviewed work history and judged likelihood that conditions could exacerbate asthma	23% (598)	24% (557)	NA
Medical center, clinics and hospital	New York City, USA [8]	Questionnaire, medical records	Physician diagnosis of asthma in 2-year period	Current job	Asthma worsens soon after starting work, or certain activities or materials at work usually worsen asthma	NA	52% (132)	NA
Referral clinic	Province of Quebec, Canada [11•]	Questionnaire, medical records, clinical tests conducted by researchers	Physician diagnosis of asthma	Current or recent job	Work-related aggravation of asthma symptoms and negative specific inhalation challenge; specific inhalation challenge common	NA	NA	58% (197)
State workers' compensation system	State of Washington, USA [9•]	Questionnaire, medical records	Physician diagnosis of asthma	Varied by subject	Physician diagnosis of asthma, symptom–work association, asthma in 2 years before entering new occupational setting, more symptoms or medication in new setting; objective testing uncommon	NA	NA	45% (301)

NA, not applicable; WEA, work-exacerbated asthma.

Workplace conditions associated with work-exacerbated asthma

A variety of conditions can exacerbate asthma. From the recent study of working adults with asthma in New York City, a majority of the participants reported that the following triggered their asthma at work or home: animals; chemicals, including cleaning products, paints, and solvents; dust; second-hand cigarette smoke; gases, fumes, odors or smoke; perfume; exercise; very cold air; hot, humid or polluted, smoggy outdoor air; and strong emotions, including stress [8]. The jobs with the highest percentage WEA were security guard or police (62%), janitor (61%), garment or textile worker (50%), administrative/support/waste management clerk (43%), restaurant cashier (43%), restaurant or bar server (42%), messenger (40%), healthcare and social assistance clerk (40%), and restaurant or bar cook (40%) [8].

From the study conducted in Massachusetts, self-reported work-related triggers of asthma symptoms or breathing problems included traditional agents (e.g. chemicals, dusts, fumes, molds), physical factors (e.g. physical exertion, changes in temperature), stress and second-hand smoke [10•]. Based on the researchers' evaluations of the participants' work histories, men were more likely than women to have experienced conditions at work that could exacerbate asthma (61 vs. 41%, respectively, $P < 0.05$).

Demographic and clinical traits of work-exacerbated asthma cases

WEA cases share traits in common with other adults with asthma and occupational asthma cases, although some differences have been noted. The study conducted in an health maintenance organization in Massachusetts observed that WEA cases were more likely to be male and to be bothered by asthma symptoms on more days during the past week than other adults with asthma [10•]. Otherwise, the two types of asthma patients were similar in age, race/ethnicity, education, annual income level, cigarette smoking, severity of asthma, and number of treatments for acute asthma attacks and number of days missed work due to asthma in the past year [10•]. WEA cases from the workers' compensation system in Washington were more likely to be female than the occupational asthma cases (i.e. 69 vs. 53%, respectively, $P = 0.006$), but both asthma types had a similar median age [9•]. The WEA cases were less likely than their occupational asthma counterparts to have received treatment from a specialist (i.e. 23 vs. 48%, $P < 0.001$), completed pulmonary function tests (31 vs. 53%, $P < 0.001$) and been tested for allergic sensitization (9 vs. 19%, $P < 0.05$).

Researchers in Quebec followed-up patients with occupational asthma ($n = 18$) and WEA ($n = 10$) for 1–4 years after diagnosis [17]. All the WEA cases and all but one of the occupational asthma cases left their jobs after diagnosis, demonstrating that both types of work-related asthma can have an adverse impact on a patient's working life and income. Spirometry, methacholine challenge results, sputum cell counts and symptom frequency were compared between when the patient was diagnosed and at follow-up. The occupational asthma and WEA cases were similar, with improvement in respiratory symptoms and little change in other clinical features by follow-up. In another study from Quebec, the investigators compared 115 WEA cases to 82 occupational asthma cases [11•]. Atopy was more common among occupational asthma (87%) than WEA (74%) cases ($P = 0.04$). The two types of cases were similar in other clinical and functional features, except for differences in specific inhalation challenge findings that were used to delineate occupational asthma from WEA.

Diagnosis and management of work-exacerbated asthma

Guidelines on preventing, diagnosing and managing work-related asthma were published prior to the time period of the current review [18–20]. More recently, the British Occupational Health Research Foundation systematically reviewed the literature and published evidence-based guidelines [21] for dealing with occupational asthma, but addressed WEA only in passing. The United States Agency for Healthcare Research and Quality completed a systematic, comprehensive review [1] of work-related asthma that also focused on occupational asthma. The Agency for Healthcare Research and Quality document acknowledged that WEA is important, but only a few of the reviewed articles addressed this topic. Other recent review articles [4,6••] provide some recommendations on the management of WEA. More severe WEA cases may require a change in jobs, while other cases might be able to remain at work if exposures were lowered and asthma medication optimized. Exposures to be minimized include nonspecific asthma triggers such as irritant gases, cigarette smoke and common environmental allergens. The lowering of exposures should be achieved by engineering controls (e.g. improved ventilation) when possible, with reliance on personal respirators only for short-term special situations. Since WEA can result in changes (e.g. job loss) largely unwanted by the patient, it is important that the treating physician refer the patient to appropriate social service programs.

Looking to the future, more comprehensive advice on the diagnosis and management of WEA is anticipated from the ATS in the next few years.

Recommendations for research on work-exacerbated asthma

Recent published reviews of literature on work-related asthma consistently call for further research on a variety

of topics related to WEA. From the section on research opportunities in the comprehensive review recently released by the Agency for Healthcare Research and Quality, the authors noted the following: 'There is limited evidence specifically examining work-aggravated asthma and OA [occupational asthma] without latency. Greater research is needed to determine optimal diagnostic and management techniques of these types of occupational asthma' [1].

In another in-depth review of work-related asthma, the author [3] observed that occupational asthma with a latency period has been the subject of most research on work-related asthma, but that WEA and irritant-induced asthma now deserved to be the focus of attention. He stated 'that almost everything needs to be done in terms of diagnosis, epidemiology, socioeconomic issues, etc.' to understand WEA [3].

The recent book chapter on WEA also recommended further research [6••]. The authors highlighted prospective medical monitoring of workers with asthma, which would start at hire in workplaces where conditions that trigger asthma are common. Ongoing exposure assessment could be combined with medical findings to further the understanding of which exposure levels pose a risk for WEA. Also, researchers could follow workers with asthma who leave their jobs temporarily or permanently due to WEA in order to document the social and economic costs of this condition. Intervention effectiveness research is also needed to document which types of programs are most successful at preventing WEA.

Finally, further investigation is needed to determine whether repeated exacerbations lead to long-term worsening of asthma, and what other risk factors, if any, contribute to such worsening [3,6••].

Conclusions

There is general agreement among researchers and clinicians that WEA is a type of work-related asthma in which existing disease is worsened by workplace conditions. Operational definitions of WEA and prevalence estimates varied considerably among recent epidemiologic studies, but the findings still lead to the conclusion that WEA is common. Numerous kinds of conditions at work can exacerbate asthma, including behavioral states, odors, second-hand cigarette smoke, and physical factors such as extreme temperatures and exercise. WEA cases share many demographic and clinical characteristics with other adults with asthma and occupational asthma cases, although some differences have been reported. Additional research is needed on all aspects of WEA in order to improve the diagnosis, management, and prevention of this condition.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 207–208).

1 Beach J, Rowe BH, Blitz S, *et al.* Diagnosis and management of work-related asthma. Evidence report/technology assessment no. 129. AHRQ publication no. 06-E003-2. Rockville: Agency for Healthcare Research and Quality. 2005.

2 Bernstein IL, Bernstein DI, Chan-Yeung M, Malo J-L. Definition and classification of asthma in the workplace. In: Bernstein DI, Chan-Yeung M, Malo J-L, Bernstein IL, editors. Asthma in the workplace and related conditions, 3rd ed. New York: Taylor & Francis; 2006. pp. 1–8.

3 Malo J-L. Future advances in work-related asthma and the impact on occupational health. Occup Med 2005; 55:606–611.

4 Mapp CE, Boschetto P, Maestrelli P, Fabbri LM. Occupational asthma. Am J Respir Crit Care Med 2005; 172:280–305.

5 Balmes J, Becklake M, Blanc P, *et al.* American Thoracic Society Statement: occupational contribution to the burden of airway disease. Am J Respir Crit Care Med 2003; 167:787–797.

6 •• Wagner GR, Henneberger PK. Asthma exacerbated at work. In: Bernstein DI, Chan-Yeung M, Malo J-L, Bernstein IL, editors. Asthma in the workplace and related conditions, 3rd ed. New York: Taylor & Francis; 2006 . pp. 631–640.
This is the first time that this book, now in its third edition, has included a chapter on work-exacerbated asthma. This chapter provides a summary of relevant articles through 2004.

7 Henneberger PK, Deprez RD, Asdigian N, *et al.* Workplace exacerbation of asthma symptoms: findings from a population-based study in Maine. Arch Environ Health 2003; 58:781–788.

8 Berger Z, Rom WN, Reibman J, *et al.* Prevalence of workplace exacerbation of asthma symptoms in an urban working population of asthmatics. J Occup Environ Med 2006; 48:833–839.

9 • Curwick CC, Bonauto DK, Adams DA. Use of objective testing in the diagnosis of work-related asthma by physician specialty. Ann Allergy Asthma Immunol 2006; 97:546–550.
This study is based on workers' compensation cases and documents how often objective tests are used to diagnose work-exacerbated asthma in the United States.

10 • Henneberger PK, Derk SJ, Sama SR, *et al.* The frequency of workplace exacerbation among health maintenance organization members with asthma. Occup Environ Med 2006; 63:551–557.
This article reports on a study of WEA in a health maintenance organization in the eastern United States. The researchers used self reports of work-related problems with asthma and a review of participants' work histories to determine who had WEA.

11 • Lemiere C, Arbour K, Teolis L, Chaboillez S. Occupational asthma and work-aggravated asthma: similarities and differences. Proc Am Thorac Soc 2006; 3:A251.
This study was conducted in the Canadian province of Quebec and is unique because participants completed specific inhalation challenge tests.

12 •• Caldeira RD, Bettiol H, Barbieri MA, *et al.* Prevalence and risk factors for work related asthma in young adults. Occup Environ Med 2006; 63:694–699.
This is an interesting population-based study of work-related asthma that was conducted in Brazil and used a questionnaire based on the European Community Respiratory Health Survey.

13 Jajosky RA, Harrison R, Reinisch F, *et al.* Surveillance of work-related asthma in selected US states using surveillance guidelines for state health departments–California, Massachusetts, Michigan, and New Jersey, 1993–1995. MMWR CDC Surveill Summ 1999; 48 (SS03):1–20.

14 Goe SK, Henneberger PK, Reilly MJ, *et al.* A descriptive study of work aggravated asthma. Occup Environ Med 2004; 61:512–517.

15 Tarlo SM, Liss G, Corey P, Broder I. A workers' compensation claim population for occupational asthma. Comparison of subgroups. Chest 1995; 107:634–641.

16 Tarlo SM, Leung K, Broder I, *et al.* Asthmatic subjects symptomatically worse at work: Prevalence and characterization among a general asthma clinic population. Chest 2000; 118:1309–1314.

17 Lemiere C, Pelissier S, Chaboillez S, Teolis L. Outcome of subjects diagnosed with occupational asthma and work-aggravated asthma after removal from exposure. J Occup Environ Med 2006; 48:656–659.

18 Bresnitz EA, Beckett W, Chan-Yeung M, *et al.* Guidelines for assessing and managing asthma risk at work, school, and recreation. Am J Respir Crit Care Med 2004; 169:873–881.

19 Chan-Yeung M. Assessment of asthma in the workplace. Chest 1995; 108:1084–1117.

20 Tarlo SM, Boulet L-P, Cartier A, *et al.* Canadian Thoracic Society guidelines for occupational asthma. Can Respir J 1998; 5:289–300.

21 Nicholson PJ, Cullinan P, Newman Taylor AJ, *et al.* Evidence based guidelines for the prevention, identification, and management of occupational asthma. Occup Environ Med 2005; 62:290–299.