CLINICAL SCIENCE

Work-related respiratory symptoms and pulmonary function tests in northeast iranian (the city of Mashhad) carpenters

Mohammad Hossain Boskabady, Majid Khadem Rezaiyan, Iman Navabi, Sara Shafiei, Shahideh Shafiei Arab

Department of Physiology and Pharmaceutical Research Centre, Medical School, Mashhad University of Medical Sciences, Mashhad, Iran.

OBJECTIVE: To assess the respiratory symptoms and pulmonary function of carpenters from the city of Mashhad (northeast Iran).

METHODS: The frequency of respiratory symptoms was retrospectively estimated in a sample of 66 carpenters in the city of Mashhad in northeast Iran using a questionnaire including questions on work-related respiratory symptoms in the past year, allergy, type of irritant chemicals that induce respiratory symptoms, smoking habits, and working periods as a carpenter. PFT values were also measured in all participants, and the age and smoking habits matched those of a sample of men from the general population as a control group.

RESULTS: Thirty-five carpenters (53%) reported work-related respiratory symptoms. Cough (34.4%) and sputum (33.3%) were the most common symptoms, and only 15.15% of carpenters reported wheezing during work. All respiratory symptoms were higher in carpenters than in controls, which was statistically significant for cough and sputum ($p<0.001$ in both cases). Most allergic symptoms were also significantly greater among the carpenters than in the control group ($p<0.05$ for both itchy eyes and sneezing). Most respiratory and allergic symptoms in the carpenters increased during work compared to rest period which was statistically significant only for cough ($p<0.05$). PFT values were significantly lower in the carpenters than in control subjects ($p<0.05$ to $p<0.001$).

CONCLUSIONS: Carpentry work was associated with a high frequency of respiratory symptoms, particularly after exposure to irritating chemicals during work. PFT values were also significantly reduced among carpenters compared to controls.

KEYWORDS: Respiratory symptoms; Carpenters; Pulmonary function test; Allergic symptoms; Respiratory disease.

Boskabady MH, Rezaiyan MK, Navabi I, Shafiei S, Arab SS. Work-related respiratory symptoms and pulmonary function tests in northeast iranian (the city of Mashhad) carpenters. Clinics. 2010;65(10):1003-1007.

Received for publication on June 13, 2010; **First review completed on** June 24, 2010; **Accepted for publication** July 20, 2010

E-mail: boskabadymh@mums.ac.ir / mhboskabady@hotmail.com

Tel.: 98 511 8828564

INTRODUCTION

Occupational diseases are a major concern, and many studies have been done to identify occupations at high risk of inducing disease. The Observatoire National des Asthmes Professionnels (ONAP) employed a network of occupational and chest physicians to report the incidence of occupational asthma in France. ONAP reported the highest risk of occupational asthma in bakers and pastry makers (683/million).[1]

Several studies have shown respiratory disorders in carpenters, including the reduction of pulmonary function tests in these workers[2] and the existence of specific IgE in some of the carpenters.[3] There is a relationship between maximal mid-expiratory flow and duration of working as a carpenter.[4] Carpenters have been shown to be susceptible to developing asthma related to their work.[5] One study documented occupational asthma among Indonesian carpenters.[6] Pulmonary function is also decreased in people exposed to wood dust and tea.[7] Immunologic mechanisms other than type I immune response have a significant role in occupational asthma induced by the red western planetree.[8] Asthma is aggravated in carpenters with more than 6.5 years of work.[9]

Although the prevalence of asthma has been studied extensively among carpenters, restrictive lung diseases and allergic symptoms have been poorly addressed among workers in this occupation.[10] In addition, there is no data regarding the respiratory status of Iranian carpenters. Therefore, the aims of this study were to assess the respiratory and allergic status of Iranian carpenters compared to unexposed controls.

Table 1 - Characteristic of control group and carpenters.

	Control group	Carpenters
Number	66 (66M)	66 (66M)
Age	28.43±8.51	28.84±8.58
PCVD	None	None
PRD	None	None
Smoking	3	4
Working time	-	8.42±1.75 hours/day
Working duration	-	10.9±2.3 years

M: male, F: female PCVD: previous cardiovascular disease, PRS: previous respiratory disease

MATERIALS AND METHODS

Population

A cross-sectional study was designed in the city of Mashhad, in the northeast of Iran, to assess respiratory and allergic symptoms and lung function in a cohort of carpenters exposed to chemicals and in a control group of unexposed people. The study included 66 carpenters (age, mean ± SD = 28.84±8.58 year) and 66 matched controls (age, M ± SD = 28.43±8.5 year) (Table 1). The carpenters worked in different carpentry businesses, and the controls were selected from the same residential district with various occupations other than carpentry. None of the control subjects had a history of respiratory illness. All studied subjects resided in Mashhad.

Participants were selected through a non-probable purposive method. All participants answered the designed questionnaire through a face-to-face interview. The study was approved by the ethical committee of our institution, and each subject gave informed consent.

Protocol

A Farsi questionnaire derived from pre-existing studies[11-14] was used to assess respiratory and allergic symptoms. The questionnaire included questions on exposure pattern, respiratory symptoms, rhino-conjunctivitis, dermal reactions, past medical history of allergic reactions, drug history, smoking habits, and working hours each week. The question about asthma referred to a history of physician-diagnosed asthma, and a follow-up question asked whether working provoked asthma attacks or aggravated the symptoms.

Carpenters were asked to list the chemical agents that they often used during work and its relation to respiratory and allergic symptoms. The questionnaire also included questions about how often they were exposed to these chemical agents.

Common risk factors such as smoking, atopy, family history of atopy, and history of allergic reactions were also asked about. Moreover, the participants answered questions regarding all employment years as a carpenter. They also stated whether they, for some reason, had quit working as a carpenter for a period of more than a year. The questionnaire also contained questions about using gloves, a mask, or ventilation during work and whether it reduced the intensity of work-related symptoms. The questions regarding respiratory and allergic symptoms were asked at the end of the working day or weekend (the weekend in Iran is Thursday afternoon and Friday) for the carpenters and only once for the control group. The questions regarding respiratory and allergic symptoms were asked in reference to the previous 24 hours (e.g., ''Have you had a cough during the past 24 hours?'').

Pulmonary function in the carpenters and control subjects was measured using a spirometer with a pneumotachograph sensor (Model ST90, Fukuda, Sangyo Co., Ltd., Japan). Prior to pulmonary function testing, the required maneuver was demonstrated by the operator, and subjects were encouraged and supervised throughout the test performance. Pulmonary function testing was performed using the acceptability standards outlined by the American Thoracic Society (ATS) with subjects in a standing position and wearing nose clips.[15] All tests were carried out between 1000 and 1700 hours. Pulmonary function tests were performed three times in each subject using an acceptable technique. The highest level for forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), peak expiratory flow (PEF), maximal mid-expiratory flow (MMEF) and maximal expiratory flow at 75%, 50%, and 25% of the FVC (MEF_{75}, MEF_{50}, and MEF_{25}, respectively) were taken independently from the three curves.

Data analysis

The data of PFT values and age were expressed as mean±SD, and the data for respiratory and allergic symptoms were expressed as a percentage of each group having the corresponding symptom. Differences in the data for the symptoms between the carpenters and the control group were tested by Chi-square analysis on 2×2 contingency tables. The data for the PFT values between the carpenters and the control group were tested using the unpaired t-test. A two-sided P value of 0.05 was the criterion for statistical significance. All analyses were performed using SPSS software (version 11.5, SPSS Inc., USA).

RESULTS

Thirty-five carpenters (53%) reported work-related respiratory symptoms. Cough (34.4%) and sputum (33.3%) were the most common symptoms, and only 15.15% of carpenters reported wheezing during work. All respiratory symptoms were higher in carpenters than in controls, which was statistically significant for cough and sputum ($p<0.001$ in both cases, Table 2). Most allergic symptoms were also significantly greater in carpenters than in the control group ($p<0.05$ for both itchy eyes and sneezing). There was no significant difference in runny nose and urticaria between the carpenters and the control group (Table 2).

Almost all carpenters were exposed to chemicals related to their job. Most respiratory and allergic symptoms in carpenters increased during work compared to rest periods, which was statistically significant only for cough ($p<0.05$, Table 3).

All PFT values except the FEV_1/FVC ratio were significantly lower in carpenters than in control subjects ($p<0.05$ to $p<0.001$, Table 4).

Sixty percent of the carpenters (39 subjects) but only 7.58% of the control group (5 subjects) had an FVC of less than 80% predicted. However, only 7.58% of the carpenters (5 subjects) and 1.15% of the control group (1 subject) had FEV_1/ FVC ratio of less than 80%.

DISCUSSION

The results of the present study showed significantly greater respiratory symptoms and lower PFT values in

Table 2 - Comparison of respiratory and allergic symptoms between control group and carpenters.

Symptoms		Control group		Carpenters		RR	95% CI	Stat. dif.	Power
		No.	%	No.	%				
R.S.	Cough	5	7.57	24	36.36	0.222	0.109-0.454	P<0.001	0.98
	Sputum	6	9.09	22	33.33	0.273	0.138-0.540	P<0.001	0.94
	Breathless	8	12.12	11	16.66	0.706	0.356-1.401	NS	0.09
	Wheezing	7	10.60	10	15.15	0.733	0.354-1.517	NS	0.13
A. S.	Sneezing	7	10.60	18	27.27	0.407	0.214-0.775	P<0.01	0.72
	Runny nose	8	12.12	10	15.15	0.800	0.395-1.622	NS	0.07
	Itchy eyes	6	9.09	15	22.72	0.333	0.165-0.673	P<0.01	0.53
	Urticaria	2	3.03	2	3.03	1.000	0.207-4.838	NS	0.04

Values are presented as the number and percentage of subjects of each group having the corresponding symptoms (for each group n = 66), Stat. dif: statistical differences, NS: non-significant differences, R.S.: respiratory symptoms, A.S.: allergic symptoms.

carpenters compared to the control subjects, indicating the effect of chemical exposure on the respiratory status of carpenters. The results also demonstrate a significantly greater amount of some allergic symptoms among carpenters, indicating that irritant chemicals related to carpentry can induce allergic reactions in people with this job. In addition, the respiratory and allergic symptoms were higher while carpenters were at work compared with time away from work. This finding confirms that chemical exposure in the work environment induces respiratory and allergic symptoms.

Several previous studies have shown increased respiratory and allergic symptoms among carpenters, supporting the results of our study. The Observatoire National des Asthmes Professionnels (ONAP) stated that the highest risks of occupational asthma were found for bakers and pastry makers, car painters, carpenters, and woodworkers,[1] which is in line with the results of our study. A reduction of the pulmonary function in carpenters was shown in a previous study and, thus, supported by the results of the present study.[2] A relationship between maximal mid-expiratory flow and duration of working as a carpenter was also demonstrated.[4] Carpenters have been shown to be susceptible to developing asthma related to their work.[5] In another study, occupational asthma among Indonesian carpenters also was documented.[6] These two later studies are also somewhat in line with the results of the present study because increased respiratory symptoms similar to asthma symptoms were found in this study. The higher incidence of asthma in carpenters with more than 6.5 years of work also has been demonstrated.[9] Pulmonary function is also decreased in people exposed to wood dust and tea.[7] In addition, it has been shown that wood dust exposure is associated with asthma, despite low dust level, suggesting that atopy is an important effect modifier in the association between asthma and wood dust exposure.[16]

In a recent meta-analysis including nineteen studies consisting of three cohort studies, twelve case-control studies and four mortality studies showed that woodworkers have a higher risk of asthma, which was more prevalent among Caucasian compared to Asian populations.[17] This study recommends future research for careful evaluation of ethnicity and nativity as risk modifiers for the prevalence of respiratory disorders among carpenters. Another recent study of 328 woodworkers and 328 controls in a Turkish population also showed that 53.7% of workers had blocked noses while working, 43.0% had redness of the eyes, 41.2% had itchy eyes, and 23.8% had runny noses, while symptoms were not observed in the control group. The mean FEV1 and FVC values of woodworkers were significantly low, although the FEV1/FVC value was high. The results of this study indicated that exposure to wood dust adversely influenced the workers' respiratory functions, which supports the results of our study.[18] Another recent study among 685 carpenters in Thailand showed significant negative correlations between mean dust exposure levels and FVC and FEV1/FVC%, but not FEV1, which suggests that wood dust exposure negatively affects lung function.[19]

In our previous studies, increased respiratory and allergic symptoms and reduction in PFT values in several occupations, including carpet weavers,[20] bakers,[21] printers,[22] and hairdressers[23] were shown. Therefore, in this study, increased respiratory and allergic symptoms as well as decreased PFT values were also shown in carpenter in the city of Mashhad (northeast of Iran) for the first time

Table 3 - Comparison of respiratory symptoms in carpenters between rest and work periods.

Symptoms		Rest period		Work period		RR	95% CI	Stat. dif.	Power
		No.	%	No.	%				
R.S.	Cough	6	9.09	24	36.36	0.250	0.127-0.492	P<0.001	0.97
	Sputum	20	30.30	22	33.33	0.909	0.604-1.369	NS	0.07
	Breathless	6	9.09	11	16.66	0.529	0.248-1.131	NS	0.22
	Wheezing	9	13.63	10	15.15	0.933	0.476-1.831	NS	0.06
A. S.	Sneezing	13	19.69	18	27.27	0.741	0.446-1.231	NS	0.19
	Runny nose	7	10.60	10	15.15	0.733	0.354-1.517	NS	0.13
	Itchy eyes	9	13.63	15	22.72	0.609	0.333-1.114	NS	0.27
	Urticaria	2	3.03	3	4.54	0.600	0.147-2.444	NS	0.06

Values are presented as the number and percentage of subjects of each group having the corresponding symptoms (for each group n = 66), Stat. dif: statistical differences, NS: non-significant differences.

Table 4 - Comparison of pulmonary functional tests (PFT) between control group and carpenters.

PFT Values	Control group	Carpenters	95% CI	Stat. dif.	Power
FVC	94.19 ± 13.83	58.34 ± 17.87	30.00 - 41.69	$p < 0.001$	1.00
FEV_1	95.88 ± 13.72	61.72 ± 17.88	28.33 - 39.99	$p < 0.001$	1.00
FEV_1/FVC	102.50 ± 11.78	107.06 ± 24.83	-35.88 - -23.43	NS	0.26
MMEF	96.14 ± 20.46	69.59 ± 32.51	16.54 - 36.57	$p < 0.001$	0.99
PEF	95.36 ± 19.86	45.39 ± 23.42	42.06 - 57.88	$p < 0.001$	1.00
MEF75%	101.40 ± 21.62	45.36 ± 26.81	47.15 - 64.93	$p < 0.001$	1.00
MEF50%	100.49 ± 27.23	68.09 ± 32.34	21.51 - 43.30	$p < 0.001$	0.99
MEF25%	102.34 ± 27.42	118.86 ± 54.42	-32.52 - -0.519	$p < 0.05$	0.58

Values are presented as mean ± SD of percent predicted (for each group; n = 66). FVC: forced vital capacity; FEV_1: forced expiratory volume in one second; MMEF: maximal mid-expiratory flow; PEF: peak expiratory flow; MEF_{75}, MEF_{50}, and MEF_{25}: maximal expiratory flow at 75%, 50%, and 25% of the FVC, respectively; Stat. dif.: statistical differences.

as recommended by the meta-analysis study of Pérez-Ríos et al.[17]

Although an increased prevalence of asthma is well-documented in carpenters, they are also exposed to various possible respiratory hazards such as wood dust, formaldehyde, solvents, copper sulfate, iron sulfate, pentachlorophenol, phenol, glues, chromates, plaster, mineral wool, insulation, polyurethane, adhesives, varnishes, and acrylates, and these workers had an elevated proportionate mortality ratio in the area of respiratory disease, including cancer.[24] Emphysema was also noted as occurring more frequently among construction carpenters.[24] The significant greater prevalence of rhinitis, asthma, conjunctivitis, chronic bronchitis, and dermatitis were also shown in carpenters compared to control subjects.[25] The study of Osman and Pala also showed an increase in the ratio of FEV1/FVC, which may indicate interstitial lung disease. In fact, the results of the present study also did not show a reduction in the FEV1/FVC ratio, which may be due to interstitial lung disease in addition to obstructive pulmonary disease.

In fact, the results of the present study showed that there was a significant decrease in FVC among carpenters, while the FEV_1/FVC ratio was normal. These results may indicate the presence of restrictive lung disease among carpenters. These findings are supported by previous studies conducted by Rastogi et al.,[10] indicating lower levels of forced vital capacity (FVC), and Robinson et al.,[24] demonstrating emphysema among carpenters. The significant reduction in FEV_1, PEF, MMEF, MEF_{75}, and MEF_{50} could be secondary to restrictive lung disease, or carpentry work may result in a combination of restrictive and obstructive lung diseases, which should be clarified in further studies. However, the results also showed increased allergic symptoms among carpenters.

This study indicated that the main reason for the reduction in pulmonary function and increased respiratory and allergic symptoms is air pollution in the workplace of carpenters, and the main irritant in the workplaces of these workers is wood dust. However, other substances that carpenters were exposed to, such as cotton fibers and glue contents or solvents, may also contribute to increased respiratory and allergic symptoms and decreased PFT values. In addition, wood contains many microorganisms (including fungi) and toxins that may affect respiratory and allergic status. In fact, agents such as terpenes, abietic acid, and plicatic acid contained in different types of wood are, potentially, implicated in the occurrence of asthma by inducing increased bronchial responsiveness or by damaging the bronchial epithelial cells.[26-28] Therefore, serious effort should be undertaken to reduce air pollution in the workplaces of carpenters. The study of Laraqui Hossini et al.,[25] as well as some other studies, also have recommended implementation of an occupational health service and development of a means for collective and individual prevention to reduce the risk maximally.

The reduction in FVC seen in the present study is much more pronounced than in other studies. This might reflect the existence of an uncontrolled working environment with characteristics different from those reported in other studies in the woodworking sector in this region of Iran. Therefore, the relevance of these findings, which suggest the presence of restrictive lung disease and possible pulmonary fibrosis should be clarified in further studies using a functional and imaging evaluation.

The questionnaire was developed using some international questionnaires in accordance with Iranian culture. Its validity and reliability were evaluated, and it was used in our previous published studies.[19-22]

CONCLUSION

The results of this study showed a reduction in the PFT values in carpenters, which may indicate restrictive lung disease among workers in this occupation. The results also showed that carpentry work was associated with a high frequency of work-related respiratory symptoms and, to a lesser extent, allergic symptoms. The symptoms are particularly aggravated after exposure to irritants in the workplace, mainly wood dust.

ACKNOWLEDGEMENTS

This study was financially supported by the Research Council of the Mashhad University of Medical Sciences.

REFERENCES

1. Ameille J, Pauli G, Calastreng-Crinquand A, Vervloet D, Iwatsubo Y, Popin E, et al. Observatoire National des Asthmes Professionnels. Reported incidence of occupational asthma in France, 1996-99: the ONAP programme. Occup Environ Med. 2003;60:136-41, doi: 10.1136/oem.60.2.136.
2. Borm PJ, Jetten M, Hidayat S, van de Burgh N, Leunissen P, Kant I, et al. Respiratory symptoms, lung function, and nasal cellularity in Indonesian wood workers: a dose-response analysis. Occup Environ Med. 2002;59:338-44, doi: 10.1136/oem.59.5.338.
3. Skovsted TA, Schlunssen V, Schaumburg I, Wang P, Staun-Olsen P, Skov PS. Only a few workers exposed to wood dust are detected with specific IgE against pine wood. Allergy. 2003;58:772-9, doi: 10.1034/j.1398-9995.2003.00127.x.
4. Meo SA. Effects of duration of exposure to wood dust on peak expiratory flow rate among workers in small scale wood industries. Int J Occup Med Environ Health. 2004;17:451-5.

5. Malo JL, Cartier A, L'Archeveque J, Trudeau C, Courteau JP, Bherer L. Prevalence of occupational asthma among workers exposed to eastern white cedar. Am J Respir Crit Care Med. 1994;150:1697-701.
6. Norrish AE, Beasley R, Hodgkinson EJ, Pearce N. A study of New Zealand wood workers: exposure to wood dust, respiratory symptoms, and suspected cases of occupational asthma. N Z Med J. 1992;105:185-7.
7. Al Zuhair YS, Whitaker CJ, Cinkotai FF. Ventilatory function in workers exposed to tea and wood dust. Br J Ind Med. 1981;38:339-45.
8. Chan-Yeung M. Mechanism of occupational asthma due to western red cedar (Thuja plicata). Am J Ind Med. 1994;25:13-8.
9. Cote J, Kennedy S, Chan-Yeung M. Outcome of patients with cedar asthma with continuous exposure. Am Rev Respir Dis. 1990;141:373-6.
10. Rastogi SK, Gupta BN, Husain T, Mathur N. Respiratory health effects from occupational exposure to wood dust in sawmills. Am Ind Hyg Assoc J 1989;11:574-8.
11. National Institutes of Health. Global strategy for asthma management and prevention: NHBLI workshop report. Bethesda, MD, January, Publication No. 02, 2002. p 3659.
12. Boskabady MH, Fasihfar M. Correlation between symptom score, reversibility of pulmonary function tests and treatment response in asthma. Iran J Allergy Asthma Immunol. 2003;2:61-7.
13. Boskabady MH, Azdaki N. Effect of inhalation technique on the bronchodilatory response to the salbutamol Inhaler in asthmatic patients. Turk Respir J. 2005;6:10-4.
14. Bellia V, Pistelli F, Giannini D, Scichilone N, Catalano F, Spatafora M, et al. Questionnaires, spirometry and PEF monitoring in epidemiological studies on elderly respiratory patients. Eur Respir J. 2003;21:21-7, doi: 10.1183/09031936.03.00402303.
15. American Thoracic Society. Standardization of spirometry: 1994 update. Official Statement of American Thoracic Society. Am J Respir Crit Care Med. 1995;152:107-136.
16. Schlünssen V, Schaumburg I, Heederik D, Taudorf E, Sigsgaard T. Indices of asthma among atopic and non-atopic woodworkers. Environ Med 2004;61;504-11, doi: 10.1136/oem.2003.007815.
17. Pérez-Ríos M, Ruano-Ravina A, Etminan M, Takkouche B. A meta-analysis on wood dust exposure and risk of asthma. Allergy 2010;65:467-73, doi: 10.1111/j.1398-9995.2009.02166.x.
18. Osman E, Pala K. Occupational exposure to wood dust and health effects on the respiratory system in a minor industrial estate in Bursa/Turkey. Int J Occup Med Environ Health. 2009;22:43-50, doi: 10.2478/v10001-009-0008-5.
19. Thetkathuek A, Yingratanasuk T, Demers PA, Thepaksorn P, Saowakhontha S, Keifer MC. Rubberwood dust and lung function among Thai furniture factory workers. Int J Occup Environ Health. 2010;16:69-74.
20. Boskabady MH, Ghayoor Karimiani E, Ahmadzadeh Vostacolaei H. Respiratory Symptoms among carpet weavers and their pulmonary function tests changes within a three year study (2002-2005) in Iran. Int J Occup Environ Health. 2007;13:369-75.
21. Boskabady MH, Taheri E, Ahmadi S, Hassanzadeh AR, Mohammadi F, Ebrahimi K, et al. Pulmonary function tests and work-related respiratory and allergic symptoms in Iranian bakers. Iran J Allergy Asthma Immunol. 2009;8:107-10.
22. Boskabady MH, Shafiei S, Shafiei Arab SS, Navabi SI, Khadem Rezaeian M. Work-related respiratory and allergic symptoms and pulmonary function tests in Iranian printers. Saudi Med J. 2009;30:179-85.
23. Hashemi N, Boskabady MH, Nazari A. Pulmonary function tests and work-related respiratory and allergic symptoms in Iranian female hairdressers. Rspir Care 2010;55:895–900.
24. Robinson CF, Petersen M, Sieber WK, Palu S, Halperin WE. Mortality of carpenter's union members employed in the US construction or wood products industries, 1987-1990. Am J Ind Med. 1996;30:674-94.
25. Laraqui Hossini CH, Laraqui Hossini O, Rahhali AE, Verger C, Tripodi D, Caubet A, et al. Respiratory risk in carpenters and cabinet makers. Rev Mal Respir. 2001;18:615-22.
26. Ayars GH, Altman LC, Frazier CE, Chi EY. The toxicity of constituents of cedar and pine woods to pulmonary epithelium. J Allergy Clin Immunol. 1989;83:610-8, doi: 10.1016/0091-6749(89)90073-0.
27. Malmberg PO, Rask-Andersen A, Larsson KA, Stjernberg N, Sundblad BM, Eriksson K. Increased bronchial responsiveness in workers sawing Scots pine. Am J Respir Crit Care Med. 1996;153:948-52.
28. Chan-Yeung M, Barton GM, Maclean L, Grzybowski S. Occupational asthma and rhinitis due to western red cedar (Thuja plicata). Am Rev Respir Dis. 1973;108:1094-02.