

Short communication

Prevalence of occupational asthma among automobile and furniture painters in the center of Eskisehir (Turkey): the effects of atopy and smoking habits on occupational asthma

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Allergy 1998; 53: 1096–1100. © Munksgaard 1998.

Background Occupational asthma (OA) is a respiratory disorder characterized by airway hyperreactivity caused by agents present in the workplace. For determination of the prevalence of OA among car and furniture painters exposed to isocyanate in the center of Eskisehir, Turkey, a clinical and epidemiologic prospective study in three phases was done, incorporating 312 (89.4%) of the painters.

Methods Of these subjects, 190 (61%) were furniture painters and 122 (39%) automobile painters. In the first phase of the study, a modified questionnaire and pulmonary function test (PFT) were done. During the second phase, peak expiratory flow rate (PEFR) was monitored in 52 subjects whose complaints were confirmed and who agreed to a month of such monitoring. In the third phase, nonspecific bronchial provocation tests (NSBPT) with histamine were done on 23 of the PEFR-monitored workers.

Results Finally, through questionnaire, typical history, PFT, PEFR monitoring, and NSBPT, 30 workers (9.6%) were diagnosed as having OA. Smoking habits and atopy in the OA-diagnosed workers were found to be statistically significantly high in comparison to the other workers.

Conclusions It was concluded that OA is a common disorder among automobile and furniture painters, and smoking habits and atopy were seen to have a significant effect on OA occurrence.

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Key words: atopy; isocyanate; occupational asthma; prevalence; smoking habits.

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Accepted for publication 10 July 1998

Occupational asthma (OA) is a respiratory disorder characterized by bronchial hyperreactivity caused by agents present in the air in the workplace; it causes obstruction or inflammation of the airway and is partially or totally reversible, spontaneously or through treatment (1).

Together with a consistent increase in the morbidity and mortality rate of asthma in many

developed countries over the past 10–20 years (2, 3), the incidence of OA is rising, as a result of increased exposure to occupational toxic agents. Although it is a relatively common disorder, the roles of smoking and atopy in its pathogenesis are not completely known (4, 5).

This study aimed to determine the prevalence of OA and the effects on it of smoking habits and atopy among workers in the automobile and

furniture-painting industry, an important area of employment in Eskisehir.

Material and methods

This study was carried out with the participation of 122 automobile painters working in the industrial district of Eskisehir and 190 furniture painters employed in the small industrial district of Baksan and the Tabakhane district (total 312 workers, 89.4% of all). A questionnaire and pulmonary function test were administered to a control group of residents in the same districts who were not painters. As these individuals were office employees of the same age group and sex, they were not exposed to isocyanate.

A modified questionnaire containing questions required for OA research and recommended by the American Thoracic Society (ATS) was used. The questionnaire, composed of 16 questions, and the pulmonary function test (PFT) comprised the first stage of our study. The eight parameters in the PFT, performed by dry spirometer, were examined. Evaluation was undertaken with the aid of the Vitalograph device, in accordance with the criteria recommended by the ATS (Vitalograph Ltd, Buckingham, UK).

Symptoms presenting after occupational exposure, exacerbations during the work week, and regression on weekends and holidays were considered a typical history. The data from the questionnaire revealed 112 individuals with respiratory complaints, of whom 62 presented with typical histories that were further evaluated in stage 2. Of these, 52 who agreed to it were monitored for peak expiratory flow rate (PEFR). Forty (77%) of the latter group could be satisfactorily recorded. PEFR records were made with the Mini-Wright peak expiratory flow meter, taken four times daily (on rising, beginning work, leaving work, and going to bed, as well as whenever a complaint occurred) over a 1-month period of 3 weeks of working days

and 1 week of holiday. These records were plotted in graphic form, incorporating work days and days off. The significance of minimum and maximum values was determined from these graphs by visual analysis and/or examination of daily PEFR variability ($\text{PEFR}_{\text{max}} - \text{PEFR}_{\text{min}} / \text{PEFR}_{\text{max}} \times 100 = \text{over } 20\%$). When two physicians agreed that the PEF graph showed a work-related change in two of the three weeks, it was recorded at work and the graph was said to be positive for OA.

In the third stage, 40 PEFR-monitored workers were called to our clinic for nonspecific bronchial provocation testing (BPT). This test was performed with histamine on 23 (58%) who had not suffered upper respiratory tract infections in the last month; who had no history of hypertension, heart disease, angina, epilepsy, or psychologic disorders; whose basic FEV₁ (forced expiratory volume 1 s) value was not below 1.5 l; and who had not been absent from work for over 24 h. The test was discontinued when a 20% drop in initial FEV₁ value was ascertained or an increase in complaints such as coughing or wheezing was determined in the patient. By means of bronchodilation, early reversibility was measured. In calculating the PC₂₀ value (the histamine concentration bringing about a 20% drop in FEV₁), 8 mg/ml or under was accepted as hyperreactivity.

Criteria used for diagnosing patients with OA include:

- 1) physician's diagnosis of asthma
- 2) an association between symptoms and work-place demonstrated by using serial PEF monitoring and/or bronchial provoking testing.

Statistical analysis

For statistical analysis of the groups, Student's *t* and chi-square tests in the SPSS (Statistical Package for Social Sciences) computer program pack were used. $P < 0.05$ was accepted as statistically significant.

Table 1. Comparison of general information and pulmonary function test results between all painters and control group

	All painters <i>n</i> = 312	Control group <i>n</i> = 25	<i>P</i>	Automobile painters	Furniture painters	<i>P</i>
Age	27.49 ± 0.51*	32.44 ± 1.76	<0.001*	29.64 ± 0.85	26.12 ± 0.62	<0.001*
Length of working time (years)	10.50 ± 0.42	—		14.21 ± 0.70	8.10 ± 0.46	<0.001*
Smoke (pack/year)	8.93 ± 9.9	8.49 ± 12.6	0.84	10.63 ± 10.7	7.83 ± 9.2	0.018*
FEV ₁ (%)	91.89 ± 1.07	98.12 ± 2.50	0.06	93.80 ± 1.52	90.46 ± 1.49	0.12
FVC (%)	93.71 ± 0.91	94.88 ± 2.43	0.68	95.51 ± 1.31	92.37 ± 1.25	0.09
FEV ₁ /FVC	83.34 ± 0.58	87.56 ± 1.04	0.02*	83.35 ± 0.78	83.34 ± 0.84	0.99

*Mean ± SE.

*Statistically significant.

FEV₁: Forced expiratory volume 1 s; FVC: forced vital capacity.

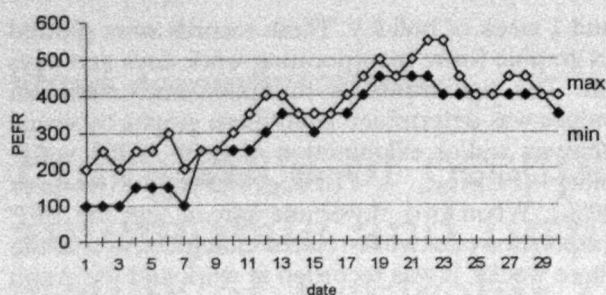


Fig. 1. Graph of patient whose PEFR monitoring was considered significant and was diagnosed as having OA (17-23 April: records from off-work period).

Results

All participants in the study were male. The average age was 27.5 years (13-65 range), and the average working time was 10.5 years (range 1-35). The pulmonary function test (PFT) was performed on a total of 213 (68%) workers. A physical examination was also done. General details and the results of pulmonary function test parameters for all the painters and the control group are given in Table 1.

Although the average age for the control group was 5 years higher, all PFT parameters for the painter group were found to be markedly low. This lowness in FEV₁/FVC levels was statistically significant. The most common complaint (27.2%) was ascertained to be a positive response to the question, "Has your chest ever sounded wheezy or whistling, for any reason, in the past 12 months?"

The painters worked an average of 8 h per workday using compressor-driven paint guns (with bottom-loaded depots) to apply the isocyanate-

containing paint polish. The paint was shown to contain 2-4 TDI (toluene di-isocyanate) and 2-6 TDI by product catalogs. This information was confirmed by the factory authorities. Protective measures included only the use of a basic face-mask and a fan for ventilation at the site of work.

In the second stage of the study, the occupation-related fall in the PEFR records for 25 (63%) of the 40 workers recorded was accepted as significant from the point of view of OA. Fig. 1 shows the graph for a single patient whose PEFR records were considered significant.

At the third stage, the nonspecific bronchial provocation test (BPT) with histamine was performed on the group of workers who had previously been PEFR-monitored. Bronchial hyperreactivity was revealed in 23 of them. Average PC₂₀ values for the 23 workers found to be positive were measured at 0.99 mg/ml (range 0.005-6.31 mg/ml).

A comparison of the complaints, allergic conditions, and PFT values of the 30 workers diagnosed with OA with those of the other workers is outlined in Table 2.

The ages and length of working time for the OA group were found to be significantly higher than for the other group. While the rate of OA in patients who had worked longer than 20 years was 23%, it was just 7.2% in those who had worked less than 20 years. The incidence of OA was seen to rise in proportion to the length of working time. A statistically significant difference between the groups was found in terms of PFT results, complaints, and durations.

Cigarette consumption (pack/year) was found to

Table 2. Comparison between OA-diagnosed painters, non-OA-diagnosed painters, and control group

	Control group	Non-OA-diagnosed painters	OA-diagnosed painters	P
n	25	282	30	
Age (years)	32.44 ± 1.76	26.91 ± 9.10*	32.93 ± 6.52	<0.001*
Length of working time (years)	—	10.0 ± 7.27	15.17 ± 7.91	<0.001*
Complaints				
Wheezing	1 4%	56 20%	29 97%	<0.001*
Breathlessness	—	34 12%	19 63%	<0.001*
Dyspnea	—	18 6%	14 47%	<0.001*
Cough	2 8%	45 16%	19 63%	<0.001*
Length of complaint (years)	—	8.66 ± 6.48	12.77 ± 7.64	0.005*
Smoke (pack/year)	8.49 ± 12.6	8.47 ± 9.64	13.23 ± 11.22	0.012*
Atopy in family	3 12%	28 10%	8 27%	0.0066*
Occupational dermatitis	—	29 10%	10 33%	0.00028*
Occupational rhinitis	—	112 40%	20 67%	0.012*
FEV ₁ (%)	98.12 ± 2.50	93.29 ± 14.35	82.97 ± 20.50	0.01*
FVC (%)	94.88 ± 2.43	93.97 ± 12.98	92.07 ± 15.56	0.48
FEV ₁ /FVC	87.56 ± 1.04	84.44 ± 7.14	76.45 ± 12.49	0.002*

* Mean ± SE.

* Statistically significant.

OA: occupational asthma.

be significantly higher among OA patients than the others ($P=0.012$) (Table 2). The starting age for smoking was also found to be lower among the OA group (15 years compared to 18 years; $P=0.08$). The PC_{20} value for smokers in the OA group, while slightly low, was not found to be statistically significant.

Allergic disorders in the family, occupational dermatitis, and symptoms of rhinitis were found at a significantly higher rate in the OA group, and the results were statistically very significant (Table 2).

While the decrease in the PFT parameter FVC (forced vital capacity) was smaller, the decrease in FEV_1 and FEV_1/FVC was more marked. The obstructive type of loss was seen to be more prominent. Exactly 93% of the patients benefited from bronchodilation, although two did not respond.

Looking at the results in general, we determined that 30 (9.6%) of the 312 paint-workers had OA. Thirteen of these were car painters (10.7% of the car painter group) and 17 were furniture painters (8.9% of the furniture painter group).

Discussion

The risk for workers exposed to isocyanates approaches 5–10% (5). Workplace exposure to this agent can cause asthma (6). Isocyanates used in the painting sector may be responsible for the high incidence of OA encountered there.

As will be understood from the definition given at the beginning, there are two elements to the definition of OA; the presence of a specific agent in the workplace, and its being shown to have a causal relation (7). For this purpose, it is necessary to obtain a thorough history. There are accepted and recommended questionnaire forms which can be used for this (8, 9).

In some epidemiologic studies, diagnosis is dependent on tests, such as the specific inhalation test, which cannot be performed everywhere (10). This situation restricts the accurate assessment of a case. With this in mind, criteria for OA diagnosis, developed, with the help of contributions from many doctors, by the NIOSH (11) and published in the form of a report, or the algorithm proposed by Cartier (7), should be applied.

In view of the fact that, while the specific BPT is the reference standard in the diagnosis of OA, PEFR records taken both inside and outside the workplace, showing occupation-related drops of 20% or more, are requisite; history and/or skin tests, with or without nonspecific BPT, can be relied upon in OA diagnosis (7, 11).

Burge et al. (12) were the first to state the reliability of PEFR in OA diagnosis (13). Malo et al. (14) report that their four-times-daily PEFR

monitoring was the most effective in ensuring patient cooperation, gave the most reliable results, and allowed highly successful evaluation. They state that records from 2 weeks in work and 2 weeks out of work are sufficient.

Working time for non-OA-diagnosed subjects was found to be 10 years, as opposed to 15 years for the OA-diagnosed subjects. This period was statistically significant; sensitization to occupational toxic agents was seen to increase in proportion to exposure. Age was seen to be significantly higher in the OA group than the others (34 years, compared to 27 years). Age was also found to be high (42.6 years) in Axon et al.'s study (15).

Cartier states that symptoms resulting from exposure begin within a few weeks or years (7). This is recorded as 3–132 months in Park & Nahm's study (16). We found the average period to be 2 years (24 months) in our study.

In a prospective study by Butcher et al., 4.3% new clinically severe asthma cases and an average annual incidence of 0.8% were seen in a factory producing isocyanate (17). In fact, this OA prevalence is related to the structure of the industrial agent, its concentration, and the working conditions. In our study, this rate was found to be 9.6%, which may be explained by the working conditions in Turkey, and the length of exposure to toxic substances in high doses.

Mastrangelo et al., using only a questionnaire, found an asthma attack prevalence of 5.8% among furniture painters with exposure to isocyanate (18). The prevalence among those having worked less than 20 years was reported as 2.2%, as opposed to 27.3% for those having worked longer. For smokers, there was a prevalence of 7.1%, as against 2.9% for nonsmokers. The risk is emphatically greatest among smokers under continuous exposure over a long period. Similarly, we found an incidence of 23% for those having worked over 20 years, as against 7.2% for those of less than 20 years.

In contrast to reports from many researchers on OA that the spirometer taken in the clinic was normal (5, 7), all spirometric values for OA cases in our study were lower than for those without OA indications (Table 2).

Although atopy is not considered a predisposing factor of sensitization to substances of low molecular weight (5, 7, 11), such as isocyanate, our study showed a markedly high rate of occupational dermatitis, rhinitis, and family histories of allergy among those exposed to isocyanate whom we diagnosed as having OA. In Tarlo & Broder's study, too, the rate of atopy was found to be higher

in the OA group (61%) than in those not so diagnosed (33%) (19).

Although it is already known that prevalence is increased by cigarettes in sensitization occurring with substances of high molecular weight, the situation with substances of low molecular weight has not been fully clarified. However, a recent study reports a highly significant relation between cigarettes and asthma risk (20). Our study also demonstrated that starting smoking earlier and smoking for a long time increases OA and that important losses in FEV₁ are incurred.

In conclusion, our study has demonstrated isocyanate-related OA to be a very common disorder among car and furniture painters, that working conditions are highly unfavorable, and that, because painters do not take sufficient precautions, this is a disorder of high incidence in Turkey. Although atopy and cigarette-smoking are not generally considered predisposing factors in occupational sensitization occurring with substances of low molecular weight, they were observed in our study to have an important effect in OA.

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