
Occupational asthma in welders and painters

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ÖZET

Kaynakçı ve boyacılar da meslek astımı

Bir bisiklet fabrikasının aynı bölümünde çalışan 3 işçide arka arkaya meslek astımı (MA) saptanmasının ardından, bu fabrikadaki MA sıklığını ve MA gelişimi ile ilgili risk faktörlerini araştırmayı amaçladık. Kırk bir kaynakçı, 23 boyacı ve 46 kontrol grubu (ofis çalışanları) olmak üzere toplam 110 olgu çalışmaya dahil edildi. Olgulara Türk Toraks Derneği Mesleki ve Çevresel Hastalıklar Değerlendirme Anketi ve gereğinde fizik muayene, akciğer grafisi ve solunum fonksiyon testleri uygulandı. Kaynakçı ve boyacılar da pik ekspiratuar akım (PEF) takibi yapıldı. Meslek ile ilişkili semptomları ve \geq %20 PEF değişkenliği olan olguların MA olduğu kabul edildi. İstatistiksel anlama ulaşmamakla beraber wheezing boyacı ve kaynakçılarda kontrol grubundan daha sıkı. Dispne, öksürük ve balgam çıkartma da kaynakçı ve boyacılar da kontrollere göre daha fazlaydı ($p < 0.05$). Dokuz (%22) kaynakçı ve 4 (%18) boyacı MA tanısı aldı. MA tanısı alan kaynakçı ve boyacıların çalışma süresi (sırasıyla 72 ve 156 ay), MA tanısı almayan kaynakçı ve boyacılar dan daha fazlaydı (sırasıyla 45, 76 ay), ancak istatistiksel olarak anlamlı değildi. Sonuçlarımıza göre, kaynak ve boya bölümlerinde çalışmanın solunumsal semptomlara ve MA gelişimine yol açabileceğini düşünmekteyiz.

Anahtar Kelimeler: Meslek astımı, boyacılık, kaynakçılık.

SUMMARY

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We aimed to investigate the frequency of occupational asthma (OA) and the factors associated with OA development in a bicycle factory, subsequently after the diagnosis of OA in three workers at the same department. Forty one welders, 23 painters and 46 controls (office workers), a total number of 110 cases were included in the study. Turkish Thoracic Society Occupational and Environmental Diseases Evaluation Questionnaire and physical examination, chest-X ray, pulmonary function tests were performed as needed. Peak expiratory flow (PEF) follow-up was done in welders and painters. Cases having symptoms related with work and $\geq 20\%$ PEF variability were diagnosed as OA. Wheezing were more frequent in welders and painters than the control group, although there wasn't a statistical significance. Dyspnea, cough and sputum production were more frequent in welders and painters with respect to controls ($p < 0.05$). Nine (22%) welder, 4 (18%) painter were diagnosed as OA. Working duration of welders and painters with OA (72, 156 months, respectively) were longer than the welders and painters without OA (45, 76 months, respectively), but it did not have any statistically significance. We suggest that working in welding and painting departments may cause respiratory symptoms and OA.

Key Words: Occupational asthma, welding, painting.

Occupational asthma (OA) is the most common occupational lung disease in industrialized countries (1). Up to 15% of all adult asthma is attributable to OA (2). OA is defined as reversible airflow obstruction which is induced by workplace exposure (3). Pre-existing asthma does not exclude the possibility of OA and also work-aggravated asthma should be considered in the differential diagnosis.

It is estimated that more than 1 million workers worldwide perform some type of welding as a part of their job. Inhalation exposure to welding fumes may vary due to differences in the materials used and methods employed. Most welding materials are alloy mixtures of metals characterized by different steels that may contain iron, manganese, chromium and nickel (4). The effect of welding fumes and gases on lung functions in welders have been investigated since 1980s (5). An impairment of pulmonary functions has not been reported in some studies, while lower pulmonary function indices than comparable controls have been demonstrated in some (6-12). Painting is another occupational exposure which isocyanates associated OA may develop (13).

In our study, after admission and diagnosis of three workers as OA from the same department of a bicycle factory, we decided to evaluate the incidence of OA and the factors contributing the development of OA in this bicycle factory.

MATERIALS and METHODS

A cross-sectional survey was designed and all the workers in the welding and painting departments as well as office workers who accepted to collaborate (approximately 40% of the factory staff) after explaining the aim and the procedure of the study were included. The bicycle factory which the study has been performed supplies more than 35% of bicycle manufacturing of Turkey and is located in Manisa Organized Industrial Zone.

A total number of 110 workers; 41 welders, 23 painters and 46 controls (office workers) were evaluated. A version of Turkish Thoracic Society Evaluation Form for Occupational and Environmental Lung Diseases which consisted from three groups of questions including working status and conditions, smoking status and medical history was administered. Questions about welding and painting related respiratory symptoms were also added (14).

Physical examination, chest X-ray and spirometry were performed whether the workers defined respiratory symptoms or not. Spirometry was done by Jaeger Master Screen Pneumo (Jaeger Co, Hoechberg, Germany) according to the criteria of American Thoracic Society (15). Also peak expiratory flow (PEF) meters were distributed to welders and painters and PEFs were followed-up for 15 days including two weekends. PEF variability was calculated accor-

ding to the formula defined in Global Initiative for Asthma (GINA) 2006.

Atopy history was defined as personal and/or familial tendency, usually in childhood or adolescence, to become sensitized and produce IgE antibodies in response to ordinary exposures to allergens, usually proteins; as a consequence, these persons can develop typical symptoms of asthma, rhino conjunctivitis, or eczema (16). Chronic bronchitis related symptoms were defined as coughing and sputum production more than three months for two consecutive years which could not be attributed to the other causes as described in Global Initiative for Chronic Obstructive Lung Diseases (GOLD).

OA was diagnosed according to the presence of all the criteria defined below: occupational exposure to known or suspected sensitizing agents, absence of asthma symptoms before beginning employment, a definite worsening of asthma after employment (loss of achieved asthma control under treatment or stepping down in the asthma control), symptom-free days out of work and determination of more than 20% PEF variability related with work days in PEF monitorization at least four times a day for a period of two weeks including work days and days away from work.

Statistical analyses were done with t-tests and chi-square, SPSS 11 package programme.

RESULTS

The workers were spending eight hours a day for six days a week in welding or painting departments. The study population consisted predominantly from males (89%). Statistical analyses were done after excluding females from the study population to eliminate gender effect, as they were all office workers, except 1 painter.

Demographic characteristics of the remaining 97 workers were shown in Table 1. There was a statistically significant difference according to age between the three groups ($p= 0.041$), office workers were older than the others, but there was not any statistical significance between welders and painters. Thirty-nine percentages of the study population had never smoked, 52% were current smokers and 9% were ex-smokers. Cigarette smoking was slightly more in welders (54%, 12.67 ± 10.64 pack/years) and painters (86%, 10.05 ± 7.00 pack/years) when compared to control (26%, 11.87 ± 11.88 pack/years) group. Table 2 shows the incidence of respiratory symptoms in the study population. Dyspnea was the most frequent symptom (26%), cough (23%), wheezing (21%) and sputum (13%) were following respectively. Cough ($p= 0.012$), dyspnea ($p= 0.001$) and sputum ($p= 0.009$) production were statistically significantly more in welders and painters with respect to control group.

Both welders and painters had a history of atopy more than the control group ($p= 0.011$). Atopy history was statistically significantly more frequent in welders than painters and control group (22%, 9%, and 0%, respectively).

Physical examination, chest X-ray and pulmonary function tests (Table 3) were not significantly different among the three groups. The confounding effect of cigarette smoking on pulmonary function tests was eliminated by stratified analyses and no significant difference was determined between the three groups. Also, chronic bronchitis related symptoms were not found to be consistent with workplace ($p= 0.125$). When welders and painters were compared, cigarette smoking was significantly more in painters, but there was not any statistically significant difference for symptoms, atopy his-

Table 1. Demographic characteristics of study population.

Subjects (n= 97)	Welders	Painters	Control (office workers)
Gender (all male)	41	22	34
Mean age	30.56 ± 8.05	33.59 ± 6.50	35.41 ± 8.03
Median duration of work (months)	48.00 (198)	95.00 (343)	44.50 (100)

Table 2. Respiratory symptoms related with work in study population.

Symptoms	Welders n (%)	Painters n (%)	Control office workers n (%)	Total n (%)
Cough*	12 (29.3)	8 (36.4)	2 (5.9)	22 (22.7)
Wheezing	10 (25.0)	6 (27.3)	4 (11.8)	20 (20.8)
Dyspnea*	12 (29.3)	11 (50.0)	2 (5.9)	25 (25.8)
Sputum*	10 (24.4)	3 (13.6)	0 (0)	13 (13.4)

* p< 0.05

Table 3. Pulmonary function parameters in study population.

	Welders	Painters	Control office workers	p
FEV ₁ % (mean)	94.65 ± 9.66	94.18 ± 10.20	96.11 ± 11.40	0.754
FVC % (mean)	97.80 ± 7.69	100.45 ± 9.36	98.02 ± 11.24	0.538
FEV ₁ /FVC % (mean)	99.31 ± 9.74	98.13 ± 7.16	98.52 ± 16.90	0.927
PEF % (mean)	73.70 ± 19.34	71.86 ± 19.57	77.32 ± 18.55	0.543

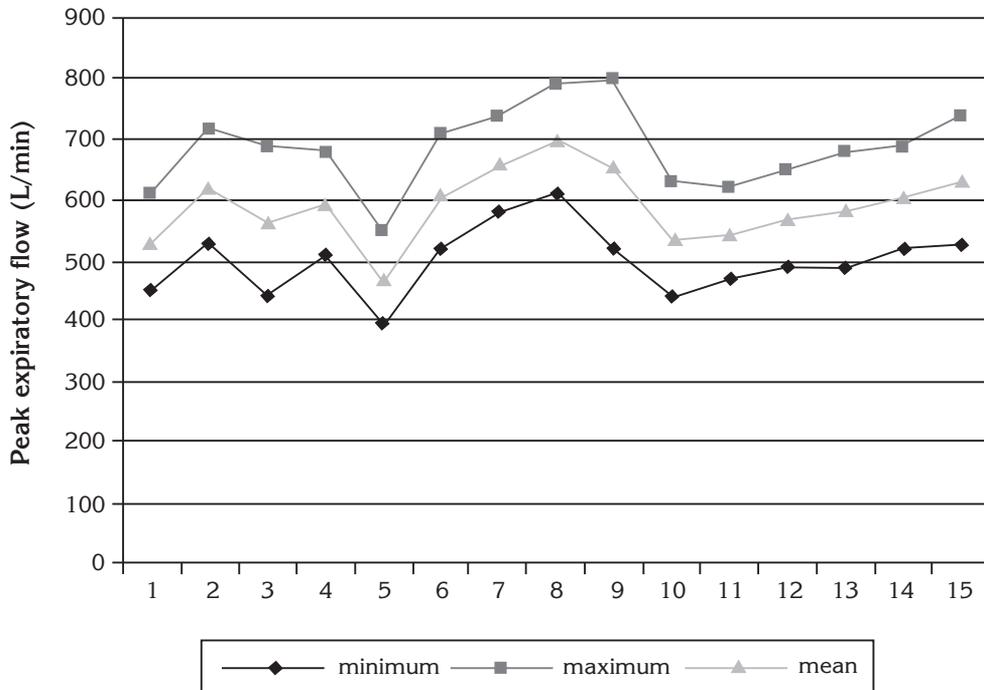


Figure 1. PEF follow-up of a patient diagnosed as having occupational asthma for a 15 days period, including consequent five work days and two days away from work, regarding the first day as a work day.

Table 4. Odds ratios for the development of occupational asthma in welders and painters.

	Odds ratio (95% CI)	p
Welders	2.06 (1.61-2.65)	0.004
Painters	2.89 (1.99-4.20)	0.010

tory, physical examination, chest X-ray and pulmonary function tests and also PEF follow-up.

OA was determined in 9 of 41 (22%) welders and 4 of 22 (18%) painters. One of the suspected PEF recordings of a welder diagnosed as OA was shown in Figure 1. There wasn't a significant difference between welders and painters for age, working duration, smoking history and pulmonary function tests according to OA presence. The incidence of OA was not statistically different between welders and painters, also. OA presence was not correlated with cigarette smoking, atopy history and mean duration of work which was 72 and 45 months in welders and 156 and 76 months in painters for OA presence and absence respectively. Odds ratios for development of OA in painters and welders were shown in Table 4.

DISCUSSION

OA is an important public health problem. Occupational lung disease may persist after cessation of exposure; however prevention is possible by improving some working conditions (17). Clinically OA presents with symptoms like episodes of breathlessness and wheezing as well as bronchial responsiveness to non-specific triggers (13).

The most useful questionnaire items in identifying subjects with OA were suggested as wheezing and nasal and ocular itching for cases exposed to high molecular agents, while any items were not defined to be associated with low molecular weight agents (18). Most questionnaire items have been produced from a list of clinical assessments of OA and include the type of the job, sensitizing agents, symptoms and the effect of weekends and/or vacations (19). Our questionnaire form was also including similar items. Malo et al. found the sensitivity and specificity of

improvement of symptoms at weekends and vacations 77-88% and 44-24% respectively (20). This wide range of sensitivity and specificity of questionnaires is one of the restricted points of our study, as one of our criteria for the diagnosis of OA was symptoms consistent with work, symptom-free days out of work.

Serial PEF self-measurements are recommended in the first-line investigation of workers with suspected OA. Anees et al. determined the sensitivity of PEF records 81% for four weeks duration and 70% for two weeks duration with the specificity of 94% and 82% respectively, in their study. A minimum required quality record was defined as ≥ 2.5 weeks duration, with ≥ 4 readings a day and ≥ 3 consecutive workdays in each work period. The sensitivity and specificity of adequate records were 78% and 92% versus 64% and 83% for inadequate records, respectively (21). We also performed serial PEF measurements according to the mentioned criteria for good quality records and serial PEF measurements were our main diagnostic criteria.

Epidemiological studies have shown that a large number of welders and painters experience some type of respiratory symptoms (22). In a cross-sectional study, which compared rates of respiratory symptoms and of physician-diagnosed asthma and chronic obstructive pulmonary disease in painters and welders, respiratory symptoms were found significantly increased among welders [odds ratio (OR)= 1.79-2.61] compared with painters or assembly workers, after age, race, and smoking status adjustments in multiple logistic regression analyses were done. Welders also reported significantly more improvement in symptoms on weekends or vacations. However, no significant increases in adjusted ORs were observed for physician-diagnosed asthma or chronic obstructive pulmonary disease for welders. In contrast, significantly more painters had physician-diagnosed chronic obstructive pulmonary disease (OR= 3.73, 95% confidence interval= 1.27, 11.0) (23). In our study, respiratory symptoms were found to be more frequent in welders and painters when compared to the control group with a statistical significance, however chronic bronchitis related symptoms were not associated with either welding or painting.

Studies of respiratory functions among welders have shown a reduction in the short term (11, 24). A 2-years follow-up study performed in welders determined no significant overall difference in the annual change of pulmonary function variables, however welders who had a history of smoking and who were working without local exhaust ventilation or respiratory protection, had significantly increased risk for accelerated decline in forced expiratory volume in one second (FEV₁) (25). Another 3-years prospective cohort study did not demonstrate chronic irreversible effects on pulmonary function tests over three years (26). Our study was a cross sectional study, so it was not possible to criticize the long term effects of welding or painting on respiratory functions and this was another limitation of our study.

Smoking has been found to be associated with the development of OA only for workers exposed to chemicals that cause asthma through an IgE mechanism like platinum salts and anhydride compounds (27). Atopy is another important factor in the development of OA, through the same route (28). Painters exposing to isocyanates who smoke have greater risk for OA. In our study, the number of painters with a history of smoking were more than the other groups; however it did not make an increase in the incidence of OA when compared to welders. Also, although the incidence of atopy history was high (22%, 9% respectively) in welders and painters, it did not effect OA presence.

Two types of OA are identified according to latency period.

1. Immunological, with a latency period of months to years after the onset of exposure and sensitization to a specific high and low molecular-weight agents.

2. Non-immunological, which may occur after single or multiple exposures to non-specific irritants at high concentrations which may be called as "irritant induced asthma" or reactive airway dysfunction syndrome (RADS) (13,28). OA, with latency period by high and some low molecular weight agents develops through an IgE mechanism. Even if different mechanisms may play a role, there is an always cell-mediated response.

In our study, although it is expected to have a latency period for isocyanates as they are high molecular agents causing immunological OA, any relationship was not determined between the presence of OA and working duration.

The prevalence of OA with latency period have been reported nearly 5% and > 5% for high and low molecular agents respectively (29). The incidence of OA in welders was reported between 1-3%, while the prevalence of OA in painters (isocyanate exposure) was reported to be 0% to 30% (5,30-32). The incidence of OA was determined 22% and 18% in welders and painters respectively in our study. This may be due to our wide diagnostic range of OA criteria and the dependence of the diagnosis to more subjective parameters like respiratory symptoms associated with work and serial PEF measurements. This is another limitation of our study. After obtaining the results of our study an institutional review was performed to help to ascertain that subjects were adequately protected.

In conclusion, OA may develop as a result of exposure to many sensitizing agents during work. Welding and painting are jobs with increased frequency of respiratory symptoms and OA risk. Workers who are intended to work in these areas should be aware of the risk, should be prevented as possible and should have health controls regularly.

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