Evaluation of Respiratory Symptoms in Workers of a Rubber Factory

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ABSTRACT

***Aim**: In this study, our objective was to investigate whether there is any relationship between working in the rubber industry and having respiratory symptoms.*

***Method**: This study was performed on 141 workers of a rubber factory. Anamnesis, physical examination and pulmonary function tests (PFT) were evaluated. Peak Expiratory Flow (PEF) follow-up and skin Prick Test were administered to the patients according to the results of respiratory system complaints, physical examination and PFT.*

***Result**: One hundred and forty one workers who accepted to participate in the study consisted of 116 (82.3%) males and 25 females (17.7%). In the comparison group with greater exposure results were obtained in the normal range, however the parameters of FEV_1/FVC and FEF_{25-75}(%) were lower in the greater exposure group. This difference was statistically significant ($p<0.05$). Variability was greater than 20% in 9 (6.3%) workers in the evaluation of PEF-meter follow-up forms.*

***Conclusion**: In conclusion, our study has demonstrated that exposure to dust and smoking in rubber industry seem to be associated with the development of occupational respiratory symptoms and diseases. That's why, control of dust exposure and cessation of smoking is important in prevention of this situations.*

***Key words**: Respiratory symptoms, rubber workers, occupational asthma*

Kauçuk Fabrikasında Çalışan İşçilerde Solunum Semptomlarının Değerlendirilmesi

Amaç: *Kauçuk fabrikası işçilerdeki mesleksel maruziyetin, solunum sistemine etkilerinin incelenmesi amaçlanmıştır.*
Metod: *Kauçuk fabrikasında çalışan 141 işçinin; anamnez ve fizik muayene sonrası solunum fonksiyon testleri (SFT) değerlendirildi. Bunların sonuçlarına göre astım düşünülen bireylere Peak Expiratory Flow (PEF) takibi ve cilt Prick Testi uygulandı.*
Bulgular: *İşçilerin 116 (%82.3) erkek ve 25 (%17.7) kadındı. Maruziyetin yüksek ve daha az olduğu grup karşılaştırıldığında FEV_1/FVC ve FEF_{2575}(%)'deki düşüklük istatistiksel olarak anlamlı bulundu ($p<0.05$). İşçilerin 9(%6.3)'unda PEF takibinde değişkenliğin % 20'den fazla olduğu bulundu.*
Sonuç: *Sonuç olarak, çalışmamızda kauçuk endüstrisinde toz ve dumanlara maruziyetin çalışmaya bağlı solunumsal semptomlar ve hastalık gelişimi ile ilişki olduğunu göstermektedir. Bu nedenle toz maruziyetinin azaltılması ve sigara bırakma önemli önlemlerdir.*

Anahtar kelimeler: *Solunumsal bulgular, kauçuk işçileri, mesleksel astım*

INTRODUCTION

Improvements in industrialization and technology accompany development of health issues among workers. Several new material and methods have entered use with the improvement of industrialization. A significant increase has been observed in the rate of health issues associated with exposure to environmental and work-related toxic substances in the last 10 years (1). Work-related inhalation of toxic substances cause various effects and defects in the respiratory system (2).

Chemical agents that are known to be toxic are used in the rubber industry. Potential risks of this industry include the inhalation of suspended dusts, organic and inorganic vapors. Most significant effects are caused by natural and synthetic rubber, elastomers, vulcanizers, secondary accelerators, activators, antioxidants, additives, freezers, preservatives, boosters, caustic agents and emollients. Most of these agents are in the form of powder and release vapor and smoke at a certain temperature. Workers of this industry are exposed to these suspended contaminations, and acute or chronic effects arise in their respiratory systems (3). Several cross-sectional studies have demonstrated an increased prevalence of respiratory symptoms, reduction in lung function, pulmonary emphysema, and premature retirement due to respiratory disease among workers of the rubber industry (4-9).

Several industry-specific studies have demonstrated the relationship between working in the rubber industry and occurrence of respiratory symptoms including increased prevalence of respiratory complaints, effects on pulmonary functioning, acute sensitizing illness with eosinophilia and chronic obstruction of the airways, respiratory symptoms with an accelerated loss of FVC and FEV_1, and an outbreak of upper and lower respiratory tract inflammatory disease and conjunctivitis (4-6,8-12). A significant risk of developing pulmonary impairment has been associated with smoking and exposure to dust and fumes in the rubber industry (13). Abnormal pulmonary functioning has been determined in smoker rubber processing workers compared to non-smokers (14). A significant number of people are employed in risky work areas in Turkey, a developing country. Rubber industry is among these areas. There are a limited number of studies in the literature on this issue and none performed in Turkey. In this study, our objective was to investigate whether there is any relationship between working in the rubber industry and having respiratory symptoms.

MATERIALS AND METHODS

This study has been performed with 141 workers of a rubber factory in Zonguldak, Turkey who accepted to participate in the study between the dates April and June 2005. Anamnesis, physical examination and pulmonary function tests were evaluated. Workers worked at three shifts of eight hours making a total of 40 hours a week. All female workers were employed in the morning shifts at the departments of packaging or office. Male workers had shifts including Sundays. All workers were categorized into occupational groups by department and job title.

Questionnaire

A questionnaire was prepared taking the questionnaire prepared by American Thorax Society and International Union Against Tuberculosis and Lung Diseases as reference15-16. A detailed form that also included personal information was filled out by interviewing each subject separately.

***Table 1**. Demographic features of both groups*

	Group 1 (n:52)	Group 2 (n:68)	p value*
Age	*29.28±5.9*	*33.08±11,83*	ns
Working time (year)	*3.33±3.01*	*3.24±3.47*	ns
Smoker	*52 (70.3%)*	*11(29.7%)*	*0.001*

***Table 2**. Comparison of pulmonary function tests by the department of workers*

	Group 1	Group 2	p value
FVC (%)	*87.8±18.2*	*85.0±16.6*	*ns*
FEV1 (%)	*89.8±18.7*	*90.9 ±16.7*	*ns*
FEV1/FVC	*86.9 ±6.6*	*92.0 ±6.4*	*0.001*
FEF2575 (%)	*93.7±26.8*	*105.8±26.2*	*0.015*

Pulmonary function tests

An initial physical examination was performed at the workplace of workers followed by a spirometer analysis (spirolab-II, Italy) at the sitting position, nose closed, with a deep inspiration followed by a forced expiration. Three measurements were performed in each subject and the best score was recorded. The spirometric pulmonary function test parameters of forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), FEV_1/FVC, expiratory flow rate between the 25-75% of vital capacity (FEF_{25-75}), peak expiratory flow rate (PEFR) were recorded. Age, height, and predicted values by body weight were also recorded.

Peak expiratory flow (PEF) Follow-up

Peak Expiratory Flow (PEF) follow-up was requested in subjects with potential asthma according to the results of physical examination and PFT. Peak flow-meter measurements were performed three times a day -before work, during work and after work- for 15 days. No measurements were performed on holidays since workers had no holidays other than sick leaves. Regularity of the measurements was checked by interviewing the workers during the follow-up period. Daily PEF variability was calculated from the follow-up forms according to the PEFmax - PEFmin/1/2 (PEFmax + PEFmin) x 100 formula. Variability more than 20% were considered significant. A variability of more than 20% between maximum and minimum PEF records during the period of exposure was considered suggestive of occupational asthma.

Prick skin test

Skin prick test (Stallergenes S.A-Pauster, France) was administered to patients with potential asthma. Latex, physiological saline as negative control, and 1% histamine as positive control were administered. Positivity criteria were 3 mm of urticaria with latex and presence of positive control. Grading of the urticarial plaque was performed as follows: 1 (+) for 3-5 mm, 2 (+) for 5-7 mm, 3 (+) for 7-10 mm, and 4 (+) for 10 mm or more. Tests and evaluations were performed by the same physician (17).

Statistical analysis

Analysis of all patient data was performed using the Statistical Package for Social Sciences (SPSS 14.0) software. Percentages and (±) standard deviation were used in descriptive analysis. Student's t-test was used in parameters of normal distribution with equal variance. The level of significance was accepted as $p<0.05$ in all statistical calculations.

RESULTS

One hundred and forty one workers who accepted to participate in the study consisted of 116 (82.3%) males with a mean age of 28.8±8.1 and 25 females (17.7%) with a mean age of 30.6±8.0. Mean duration of working at the rubber factory 3.7±3.7 with a minimum of 1 and a maximum of 20. Smokers constituted 59.5% with a mean amount of 8.55±1.65 package-years. Medical history of the subjects revealed hay fever in 22 (15.6%), urticaria in 4 (2.8%), eczema in 11 (7.8%) and none had history of acute asthma crisis or a diagnosis of asthma. Fifteen patients (10.6%) had family history of asthma. Results of the questionnaire demonstrated that 23 (16.3%) subjects had cough, 42 (29.8%) had sputum production, 20 (14.2%) had dyspnea, and 7 (5.0%) had wheezing. Cough was more significant in the winter months for longer than three months in 7 (5%) subjects. Fifteen (10.6%) subjects reported that they considered these symptoms to be work-related and 13 (9.2%) reported improvement or resolution of symptoms on off-days. Pulmonary function test was performed in 141 subjects and results were incompatible to the test in 21 subjects. Workers were separated into two groups according to the overall fea-

Table 3. Distribution of workers by department and potential diagnosis of asthma.

Department	Subjects, n	%	Potential asthma, n
Metal	29	20.6	9
Mould	12	8.5	-
Office	15	10.6	-
Packaging	26	18.4	-
Press	43	30.5	5
Dough	16	11.3	-
Total	141	100	-

tures of their departments. Group 1 consisted of workers from departments of dough and galvanization where several chemicals were used and vapor and smoke exposures were high, and Group 2 consisted of workers of packaging and office departments where exposure was no or low levels. Workers of the latter group were not subject to shifts or change of departments since they performed qualified work. Demographic features of both groups were demonstrated in Table 1. According to this table, no difference were obtained between the groups concerning age and working duration. But, there was a significant difference for the smoking ($p<0.001$). Pulmonary function test results of the groups are demonstrated in Table 2. Pulmonary function test results of both groups were obtained in the normal range; however, the parameters of FEV_1/FVC and FEF_{25-75} were statistically significantly lower in Group 1 ($p<0.05$).

Skin prick tests and 15-day PEF meter follow-ups were performed in 14 (9.9%) male subjects with positive physical examination findings and wheezing. Variability was more than 20% in 9 (6.3%) workers according to the PEF meter follow-up forms. These workers were considered as potential asthma patients. Distribution of workers who were potential asthma patients is demonstrated in Table 3 by their departments. Test results were negative in 14 workers who underwent latex skin prick test. History of hay fever plus eczema was present in 2 of these workers, and hay fever alone was present in 3 workers. The rates of hay fever and eczema were 35.7% and 14.2%, respectively. Urticaria, asthma and family history of asthma were determined in none of the patients. Chronic obstructive pulmonary disease (COPD) was determined in 1 (0.8%) patient.

DISCUSSION

Workers of rubber industry are subject to toxic substances that are often in powder form and release vapor and smoke leading to contaminants that remain in suspended form in the air. This exposure leads to obstruction of smaller and greater airways. Some of these contaminants might lead to acute or chronic effects on the respiratory system including chronic bronchitis, dyspnea, and bronchial asthma (3). Symptoms of cough, sputum production, dyspnea, and wheezing were determined in 23 (16.3%), 42 (29.8%), 20 (14.2), 7 (5.0%) subjects, respectively. The rates of cough, sputum production and dyspnea have been reported as 68.5%, 64.1% and 70.9% in 10-year series performed with rubber workers3. Our results were lower than that reported in the literature possible because of lower duration of working (3.7±3.7) of our population. Studies performed on the rubber industry have reported symptoms of chest pain and dyspnea lasting throughout the shift and acute onset of cough, dyspnea and pressure sensation on the chess upon return to work after a break (3,10,18). In our study, fifteen (10.6%) subjects reported that they considered these symptoms to be work-related and 13 (9.2%) reported improvement or resolution of symptoms on off-days. These results indicate that work-related influences are present in this area of work.

Smoking and exposure to industrial smoke and powders have been suggested to be important risk factors of developing respiratory disease in the rubber industry (13,18). Significant impairment of pulmonary functioning have been determined in the comparison of smoker and non-smoker workers of rubber industry (14). Chronic bronchitis and other pulmonary diseases are also more frequent among workers of departments where exposure is greater (4-6).

Co-existing factors such as smoking with dust exposure have negative impact on respiratory functions and it leads to some illnesses (COPD, asthma, etc.) (8-12). In our study we found that smoking is significantly higher in dust exposure group. Accordingly, due to effect of both dust exposure and smoking, FEV_1/FVC and FEF_{2575} values were found to be decreased in the study group.

Occupational exposures to dust, smoke and gases have an important role in the development of COPD. Mine workers (including silica, cadmium and coal), metal workers, transporters, workers of wood/paper manufacturers, cement, grain and textile workers are examples

of occupational groups at high risk of COPD. The risk of developing COPD is even greater among workers at occupational risk who also smoke. Smoking is the primary factor in the etiology of COPD in 70-80% of subjects, although other risk factors also play roles (19-20). Age of onset of smoking, total duration of smoking, and the daily number of smoking are important factors in the development of COPD (21). Chronic obstructive pulmonary disease has been determined in 25% of subjects, that have an exposure history longer than 10 years, and the rates of mortality due to asthma, bronchitis and emphysema are markedly higher among workers of rubber industry (6,22). Smoking should also be evaluated in the assessment of chronic obstructive pulmonary diseases secondary occupational causes. In our study, COPD was determined in 1 (0.8%) subject who worked in this industry for longer than 10 years and smoked. This low rate possibly results from the shorter total duration of working of our population in the industry.

History suggestive of occupational asthma was present in 14 (9.9%) of the 141 subjects with positive physical examination findings and history of wheezing. Respiratory function questionnaires and serial PEF measurements have been reported to be possible alternatives of NSBPT in demonstration alterations in airways (23). Therefore we administered PEF to subjects with occupational asthma. Significant variability was determined in the 15-day PEF follow-up of 9 (6.3%) subjects with normal PFT. Results of PEF could not be evaluated properly, since almost all of the workers had exposure 7 days a week. These subjects were defined as occupational asthma patients; however we could not meet the 4 daily PEF measurements criteria recommended in the literature with only three measurements as before work, during work and after work. This was considered as one of the limitations of our study.

Determination of specific immunglobulins or positive reaction to the exposure agents in skin tests are important elements of a diagnosis of occupational asthma. However, the presence of specific immunoglobulins and positivity of skin tests do not always indicate a disease, they only suggest sensitization and/or exposure. Determination of positivity in subjects with known occupational asthma helps to determine the exact agent and supports the diagnosis of occupational asthma (24). Therefore, we administered skin prick tests for latex to our subjects. However, positivity was not determined in skin prick tests of any one of the subjects with potential asthma. Natural working environment of workers included elastomers, vulcanizers, secondary accelerators, activators, anti-oxidants, additives, freezers, preventatives, boosters, caustic agents and softeners besides natural and synthetic rubber. Limited number of agents could be examined since there were not adequate standardized skin tests for occupational asthma. Hence, we could not demonstrate sensitization and/or exposure to these agents. In addition, we could not perform specific immunoglobulin detection due to technical-financial limitations.

The prevalence of occupational asthma varies by the areas of work. The great majority of epidemiological studies have been performed with workers who were still employed. Disease prevalence is therefore determined rather lower (1). Occupational asthma secondary to latex has been determined at a rate of 9-16% in the literature (25-26). Nine subjects (6.3%) were determined as potential asthma patients in our study. This figure is close to those reported in the literature. However, the difference in rates might be due to methodological differences or the difference in local industrial activities.

Study Limitations; this study was performed on active factory workers, and there are no data regarding exworkers who are thought to be at greater risk in terms of chronic effects. Concentration of dust could not be measured in the factory we examined. The amount of dust and respiratory effects could be compared if dust concentration could be measured. In addition, the difference between departments could be better evaluated in that case. Potential effects of the duration of exposure on respiratory symptoms could not be evaluated due to the direct effects of environmental ventilation, limited number of subjects and homogenous distribution. A control group could therefore not be constituted. Instead office and packaging personnel who worked under the same ventilation environment but were not subject to toxic inhalants used for comparison. Results of our study should be evaluated with consideration of these limitations. The aim of our study primarily to determine respiratory symptoms and to detect diseases that can be with these complaints. So that diagnosis of occupational asthma has been missing in this study. It could be better when postbronchodilator PFT had done but due to the existing facility and the time it did not happen. And this is the limitation of our study.

In conclusion, our study has demonstrated that exposure to dust and smoking in rubber industry seem to be associated with the development of occupational respiratory symptoms and diseases. That's why, control of dust exposure and cessation of smoking is important in prevention of this situations.

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