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RESPIRATORY SYMPTOMS AND PEAK EXPIRATORY FLOW RATES AMONG FURNITURE-DECORATION STUDENTS

Peri Arbak[1], Cahit Bilgin[1], Oner Balbay[1], Nuray Yeşildal[2], Ali Nihat Annakkaya[1], Füsun Ulger[3]

[1]Abant Izzet Baysal University, Medical Faculty, Department of Pulmonary Diseases, Düzce, Turkey
[2]Abant Izzet Baysal University, Medical Faculty, Department of Public Health, Düzce, Turkey
[3]Ankara University, Medical Faculty, Department of Pulmonary Diseases, Ankara, Turkey

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Abstract: This study was designed to evaluate the effects of furniture production, mainly including fir tree (aberia mulleriana), on respiratory health of young workers and to compare the results with those obtained from previous studies. Sixty-four furniture-decoration students (57 males and 7 females) and 62 controls (54 male, 8 female) from different departments in the same school were included into the study. All participants were assessed with a questionnaire (concerning history of occupational exposure, work-related respiratory and other symptoms, smoking history, previous asthma history), full physical examination, spirometric evaluation and chest radiograph. Participants then performed serial monitoring of peak expiratory flow rates (PEFR) at work and away from work within a month. Mean age of students was 20.9 ± 3.7 years, 20.5 ± 2.6 years in controls. There was no difference between study and control groups with regard to age, gender, smoking status and previous asthma history. Reported cough (23.4% *vs.* 8.1%) and shortness of breath (18.8% *vs.* 6.5%) were significantly higher in furniture-decoration students than in controls (p = 0.016 and p = 0.034, respectively). Furniture-decoration students had higher conjunctivitis (34.4% *vs.* 9.7%, p = 0.001) and rhinitis (34.4% *vs.* 19.4%, p = 0.044) history when compared with controls. Both students and controls were normal in terms of respiratory examination. PEF recordings were performed for approximately one month. Diurnal variability greater than 20% was seen in 12/64 (18.7%) of students at work, whereas it was detected in 4/62 (6.4%) of controls (p = 0,034). When comparing for the presence of diurnal variability greater than 20% in weekends, no difference was found between groups (p = 0.457). In conclusion, early detection of work-related respiratory changes by serial monitoring of peak expiratory flows should save the workers from hazardous respiratory effects of the furniture production, especially in young population.

Address for correspondence: Peri Arbak, MD, Abant Izzet Baysal University, Düzce Faculty of Medicine, Department of Pulmonary Diseases, Düzce, Turkey.
E-mail: periarbak@hotmail.com

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INTRODUCTION

Respiratory health effects have been documented in furniture production workers due to the exposure to a variety of wood dusts, chemicals and microorganisms [15, 18, 28]. Furniture production related respiratory disorders include occupational asthma, non-asthmatic chronic airflow obstruction, extrinsic allergic alveolitis, organic dust toxic syndrome and simple chronic bronchitis [11, 26, 28].

Among woods, western red cedar is the most investigated agent which causes occupational asthma, whereas other types of wood dust such as pine, spruce, fir have

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only received limited attention [3, 9, 16]. Few studies showed that occupational asthma, lung function impairment and increased respiratory symptoms were detected among workers exposed to pine, spruce and fir dusts [16, 20]. In furniture factories not only wood dusts but also chemicals (formaldehyde, isocyanate etc.) and microorganisms (bacterial, fungal spores) have been accused for the development of respiratory diseases such as occupational asthma, extrinsic allergic alveolitis, organic dust toxic syndrome [1, 3, 10, 24]. In a study, painters in the furniture industry, particularly atopic subjects, were found to be at high risk of asthma-like symptoms. In these workers, asthma-like symptoms were more sensitive than non-specific bronchial hyperreactivity in detecting a negative effect of the occupational exposure [30].

Previous studies have reported different prevalence rates of respiratory and other symptoms related to wood processing. Hessel *et al.* reported that the prevalence rates of bronchitis and asthma in sawmill workers exposed to pine and spruce were 26.6% and 7.4%, respectively [16]. Prevalence of occupational asthma due to western red cedar ranged from 4% to 15% in different studies [2, 4, 31].

Few reports have focused on respiratory impairment related to wood processing and furniture production in Turkey. Erdoğan *et al.* found the prevalence of occupational asthma to be 2.5% among 163 furniture production and sawmill workers [13]. Fişekçi *et al.*, in a cross-sectional study which included 138 furniture polishers and painters, reported the occupational asthma rate as 4.3% [14].

The aims of the present study were to evaluate the effects of furniture production, mainly fir tree (aberia mulleriana), on respiratory health of young-aged workers and to compare the results with those obtained from previous studies.

MATERIALS AND METHODS

This study was performed in the furniture-decoration department of a high school in Düzce, a rural area in northwest Turkey, between September and December 2002.

Study Population. A total number of 64 furniture-decoration students (57 males and 7 females) were included in the study. Mean age was 20.9 ± 3.7 years. Duration of training in the furniture-decoration department ranged from 1–2 years. 62 students (54 male, 8 female) from different departments in the same school served as controls. Mean age was 20.5 ± 2.6 years. All subjects gave written informed consent and the study was approved by the Ethics Committee of Abant Izzet Baysal University Medical Faculty.

Workplace. The area of the furniture-decoration unit was 20 × 7 × 6 m^3. In each shift 16 students (52.5 m^3 per student or 0.02 student per m^3) were working at the same time. Briefly, the furniture-decoration process consists of 4 main activities: 1) Sawing and trimming the woods, mainly fir and sometimes pine, 2) Grinding the products, 3) Painting and polishing the products (the formulations of paint and varnish were alkyd and nitro-cellulose based, respectively. Toluene was used as thinner) 4) Glueing the parts of furniture (formaldehyde based glue).

A central vacuum connected to all the woodworking machines was used to reduce the wood dust exposure. Students were also encouraged to use face masks and protective glasses during dusty woodworking processes. Students worked in the furniture unit twice per week for 4 hours.

The measurement of dust levels could not be performed due to the lack of laboratory facilities.

Diagnostics Procedures. A questionnaire was used to record the work-related symptoms (cough, shortness of breath, wheezing, chest tightness, rhinitis, conjunctivitis, urticaria), smoking habits, previous asthma-allergy history and occupational history.

At the beginning, all subjects were assessed with physical examination, pulmonary function testing and chest radiograph. Chest radiographs were performed in the Radiology Department of the University Hospital. Both groups were examined and investigated during the same period, with the same staff (physician and technician) and equipment. Forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), forced mid-expiratory flow between 25–75% of FVC ($FEF_{25-75\%}$) and peak expiratory flow (PEF) were measured in all subjects using a spirometer (Vitalograph Alpha). Three technically acceptable measurements were made for each subject and all volumes were corrected to body temperature and pressure saturation (BTPS). Results were expressed as percentages of the predicted values [27]. Spirometric tests were repeated at the end of the study (after approximately a month). Mini-Wright peak flowmeter and diary card were used for PEF monitoring. Firstly, subjects were trained in the use of the peak flowmeter and to record the measurements of PEF on working days and record exposure on a diary card. Students also were told to record their PEF 4 times daily (on waking, noon, after work and before bedtime) for at least 1 week to 10 days when away from work [7]. According to the furniture-decoration education programme, students recorded their PEF measurements during a month. The sum of the weekend records at least 1 week to 10 days was accepted as PEF monitoring away from work, the remaining PEF records reflected PEF monitoring at working period.

For analyzing PEF records, a quantitative method was used [19]. The following criteria were used: (1) a 20% or greater diurnal variability of peak flow readings to make a diagnosis of asthma, (2) the occurrence of such changes relatively more frequently on working days than off work days, (3) exclusion of indeterminate findings such as occurrence of diurnal change only on one occasion or occurrence of PEF changes without diurnal basis. Diurnal variation of PEF was calculated as follows:

$$\frac{\text{MaxPEF} - \text{MinPEF}}{\text{MaxPEF}} \times 100\% \text{ [19].}$$

Definitions. In accordance with ACCP consensus statement [6], we diagnosed OA and likely OA as follows:

(A) Diagnosis of asthma and (B) onset of asthma after entering the workplace; and (C) association between symptoms of asthma and work; and (D) one or more of the following criteria: (1) workplace exposure to an agent known to give rise to OA; or (2) work-related changes in FEV1 or peak expiratory flow (PEF) rate; or (3) work-related changes in bronchial responsiveness; or (4) positive response to specific inhalation challenge tests; or (5) onset of asthma with a clear association with a symptomatic exposure to an irritant agent in the workplace.

Occupational asthma: meets A+B+C+D2 or D3 or D4 or D5 of the surveillance case definition.

Likely occupational asthma: meets A+B+C+only D1 of the surveillance case definition.

Statistical Analysis. SPSS-8.0 package programme was used for statistical analysis. Students and control subjects were compared by using the Student's t test for numeric variables and the chi^2 or Fisher exact tests for categoric variables. Additionally, interaction between smoking and wood dust exposure was determined by log-linear analysis. A p value of < 0.05 was considered significant.

RESULTS

The demographical characteristics and work-related symptoms of furniture students and controls are shown in Table 1.

There was no difference between the students and controls with regard to age, gender, smoking status and previous asthma history.

Reported cough (23.4% *vs.* 8.1%) and shortness of breath (18.8% *vs.* 6.5%) were significantly higher in furniture-decoration students than in controls (p = 0.016 and p = 0.034, respectively). Furniture-decoration students had higher conjunctivitis (34.4% *vs.* 9.7%, p = 0.001) and rhinitis (34.4% *vs.* 19.4%, p = 0.044) history when compared with controls.

Both students and controls were normal in terms of respiratory examination. Although the difference was not statistically significant, furniture-decoration students had higher conjunctivitis (10.9% *vs.* 3.2%, p = 0.090), urticaria (3.1% *vs.* 1.6%, p = 0.512) and rhinitis (6.3% *vs.* 3.2%, p = 0.355) than controls in physical examination.

Chest radiographs of all the students and controls were normal.

Table 1. Demographical features and work-related symptoms of students and controls.

	Students n = 64	Controls n = 62	p
Age: years, mean (SD)	20.9 (3.7)	20.5 (2.6)	0.473
Gender			
Male% (n)	89.1 (57)	87.1 (54)	0.474
Female% (n)	10.9 (7)	12.9 (8)	
Smoking status			
Smokers% (n)	50.0 (32)	38.7 (24)	
Nonsmokers% (n)	47.2 (27)	56.5 (35)	0.645
Exsmokers% (n)	7.8 (5)	4.8 (3)	
Previous asthma diagnosis% (n)	4.7 (3)	4.8 (3)	0.645
Work-related respiratory complaints			
Cough% (n)	23.4 (15)	8.1 (5)	0.016*
Shortness of breath% (n)	18.8 (12)	6.5 (4)	0.034*
Chest thightness% (n)	15.6 (10)	9.7 (6)	0.230
Wheezing% (n)	14.1 (9)	4.8 (3)	0.071
Other complaints			
Rhinitis% (n)	34.4 (22)	19.4 (12)	0.044*
Conjunctivitis% (n)	34.4 (22)	9.7 (6)	0.001*
Urticaria% (n)	6.3 (4)	1.6 (1)	0.193

*p value lower than 0.05 was considered significant

Pulmonary function parameters are shown in Table 2.

Baseline PEF value of students was significantly lower than controls (89.8% *vs.* 101.5%, p = 0.002*). After study, the FVC value of students was found to be higher than controls (104.1% *vs.* 99.4%, p = 0.038).

Table 3 shows total working and weekend days when the study was performed, subjects who had diurnal variability greater than 20% on working days and weekends, mean working and weekend days with diurnal variability greater than 20%.

PEF recordings were performed for approximately one month. Diurnal variability greater than 20% was seen in 12/64 (18.7%) of students at work, whereas it was detected in 4/62 (6.4%) of controls (p = 0.034). When assessing for the presence of diurnal variability greater than 20% at weekends, no difference was found between the groups (p = 0.457). Serial recordings of peak expiratory flows of the 8th and 17th students having diurnal

Table 2. Spirometric values at the beginning and end of the study.

	Before study			After study		
	Students	Controls	p	Students	Controls	p
FVC (% predicted values)	96.7 ± 14.6	100.3 ± 12.1	0.139	104.1 ± 13.6	99.4 ± 11.6	0.038*
FEV_1 (% predicted values)	102.9 ± 14.0	107.6 ± 13.3	0.053	109.7 ± 13.4	106.0 ± 13.2	0.130
$FEF_{25-75\%}$ (% predicted values)	103.2 ± 23.0	108.0 ± 23.4	0.256	108.9 ± 21.7	105.3 ± 22.8	0.369
PEF (% predicted values)	89.8 ± 20.6	101.5 ± 20.7	0.002*	101.4 ± 16.1	104.9 ± 18.9	0.268

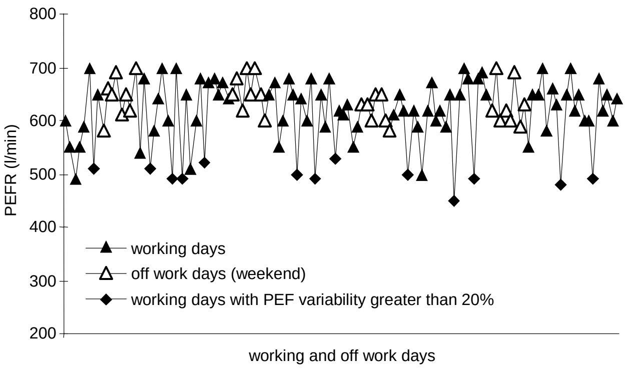

Figure 1. Serial recordings of peak expiratory flow of 8th student having diurnal variability greater than 20% during working days.

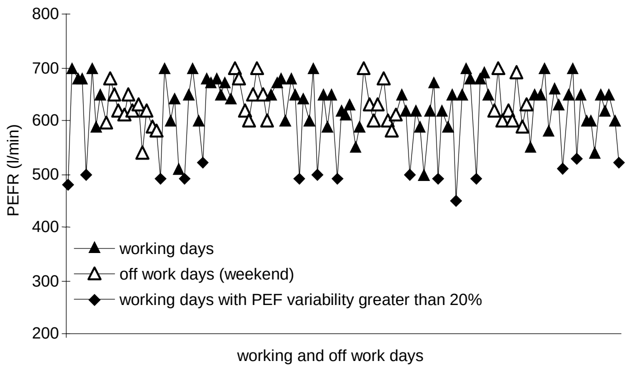

Figure 2. Serial recordings of peak expiratory flow of 17th student having diurnal variability greater than 20% during working days.

variability greater than 20% during working days are shown in Figure 1 and 2.

A log-linear analysis made on the smoking and wood dust exposure showed no interaction effect between smoking and wood dust exposure ($p > 0.05$).

DISCUSSION

Most of the previous studies that revealed the respiratory health effects related to woodworking and furniture production demonstrated the long-term exposure effects on workers. Additionally, those studies included middle-aged workers [9, 18, 22, 23, 28]. The present study investigated furniture production related respiratory effects in a younger age group than those of other studies. This study also showed the earlier effects of exposure to wood dust and other materials included in furniture production.

The natural history of red cedar asthma includes a latent period between the onset of exposure and symptoms [5]. The duration of the latent period remains unclear in red cedar asthma, whereas the incidence-density of rhinoconjunctivitis symptoms is higher in years 1 and 2 after exposure and respiratory symptoms become more relevant in years 2 and 3 in laboratory animal workers asthma [21]. In our study, students were exposed to fir dust for 1–2 years. The reported rhinitis and conjunctivitis in furniture-decoration students (22% and 22%, respectively) were found to be higher than controls (12% and 6%, respectively). Our results were consistent with the study by Milanowski in that rhinoconjunctivitis occurred in a group of workers who had a shorter mean duration of employment [25].

Table 3. PEF diurnal variability in subjects.

	Students n = 64	Controls n = 62	p
Working days, mean ± SD	19.6 ± 2.5	20.2 ± 2.1	0.300
Off work days, mean ± SD	10.7 ± 2.7	9.9 ±1.9	0.261
Subjects with diurnal variability greater than 20% on working days, % (n)	18.7 (12)	6.4 (4)	0.034*
Subjects with diurnal variability greater than 20% at weekends, % (n)	9.3 (6)	9.6 (6)	0.596
Working days with PEF variability greater than 20%, mean ± SD	7.7 ± 4.8	4.7 ± 2.9	0.272
Weekends with PEF variability greater than 20%, mean ± SD	5.3 ± 3.0	4.1 ± 2.0	0.457

Work-related cough and shortness of breath were higher in students (15% and 12%, respectively) when compared with controls (5% and 4%, respectively) in our study. Moreover, in this study respiratory complaints were seen earlier (1 to 2 years after exposure) than in a study investigated laboratory animal workers asthma [21].

A relatively short period between rhinoconjunctivitis and respiratory symptoms in our study was thought to be related to the involvement of both immunologic and nonimmunologic mechanisms in furniture production related asthma-like symptoms. Since a formaldehyde based glue was used in this particular environment it could be thought that these symptoms may be due to formaldehyde exposure, although a potential causal role for other exposures cannot be excluded. Moreover, most of the inhaled formaldehyde is retained in the upper respiratory tract due to its extraordinary solubility. Therefore, cases of formaldehyde-induced occupational asthma are sporadic despite its widespread use in industrial processes [17]. Although the prevalence rates of cough and shortness of breath in the present study were found to be lower than those of other studies [16, 25, 28], our results were similar to those obtained from a study including intermittent and low exposed pine sawmill workers [9]. In another study, a minor part of the respiratory symptoms in furniture industry workers was explained by pine-specific IgE [29].

Spirometric values in the present study did not show any changes attributable to the hazardous effects of furniture production working. This result may be explained with relatively younger workers, and the intermittent and lower exposure in our study. In a study by Shamssain *et al.*, FEV_1/FVC and FVC were found to be lower in the exposed workers who had been employed for at least 10 years in a furniture factory [28]. Some studies evaluating the respiratory effects related to woodworking reflected evidence of airway obstruction while others described restrictive defects only [8, 16, 28, 31]. In our study, the differences in the baseline value of PEF and in FVC at the end of the study might be related to the spirometric performance of subjects and technician, effort dependence of FVC and PEF maneuvers, and learning effect combination.

PEF monitoring was used as a screening test in establishing work relatedness of respiratory symptoms and to evaluate the safety of work environment in the present study. Although PEF monitoring requires cooperation and training, it still remains a useful and cheap method in screening possible occupational asthma, especially in developing countries. Our study showed that 18.7% (12/64) of students had significant diurnal variability greater than 20% on working days, whereas 6.4% (4/62) of control subjects had such changes in PEF. In the case of diurnal variability greater than 20% at weekends there were no difference between students and controls (9.3% and 9.6%, respectively). We pointed out that the effects of age, gender, smoking status and previous asthma history on PEF recordings were excluded by matching the students and controls [12].

Although students with PEF diurnal variability greater than 20% did not meet the criteria for occupational asthma in surveillance case definition [6], we suggest that furniture production including fir tree was associated with higher risk for the development of respiratory complaints. Further studies are needed to assess whether early recognition can be best achieved by appropriate surveillance programmes in furniture production industries such as those using fir tree and various chemicals that account for most suspected occupational asthma cases.

In conclusion, early detection of work-related respiratory changes by serial monitoring of PEFs recordings should save the workers from hazardous respiratory effects of the furniture production, especially in the younger-aged population. A further study must be carried out to detect the nature and the level of exposure, and measures should be undertaken to lower the exposure to offending agents by substitution or by improving exposure controls at the workplace.

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