Abstract

It is considered that occupational exposure (OA) accounts for up to 25% of cases of adult-onset asthma [1]. OA can cause asthma; it can also aggravate a pre-existing condition. Work-related asthma is a broad term that refers to asthma exacerbated or induced by exposures in the workplace [2]. Furthermore, depending on the pathogenic mechanism involved, OA is subdivided into immunological and nonimmunological forms. Immunological OA is characterized by asthma appearing after a latency period and can be caused by high- and low-molecular-weight agents that are either IgE-mediated or not. Irritants induce nonimmunological OA [3].

In Turkey, information regarding the relationship between asthma and work-related symptoms is scarce. This data would help to inform workplace policies, as well as raise awareness about occupational triggers for asthma among patients and clinicians. Previous studies have demonstrated the risk of asthma in certain occupations, including hairdressers, car painters, furniture makers, and healthcare workers [4–8]. However, to our knowledge, no study has evaluated occupational and workplace exposures of patients with asthma in Turkey. Moreover, housewives, who constitute the majority of asthmatic subjects in the outpatient clinics in Turkey, have not been evaluated in prior occupational asthma studies. Recent reports show that professional cleaners have high rates of asthma-like symptoms in Europe and North America [9]. Indeed, housewives in our country are exposed to a large number of chemical cleaning products [10].

The study was presented as poster discussion in European Respiratory Society congress in 29 September 2015, Amsterdam, Netherlands.

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This study aimed to investigate the association between asthma symptoms, occupation type, and workplace-associated exposures in patients with asthma at seven tertiary chest disease clinics in Turkey.

**MATERIAL AND METHODS**

This cross-sectional, multicenter, questionnaire-based study was conducted in seven locations across Turkey between May 2014 and January 2015. The study was approved by the local ethics committee of Ankara University (24-466; 14.01.2011) and performed in accordance with the Declaration of Helsinki. Informed consent was obtained from all patients.

**Study Population and Study Areas**

The study population comprised adult patients who had been diagnosed with asthma for at least six months prior to study and who were under follow-up in the pulmonary disease clinics in Ankara, Istanbul, Erzurum, Düzce, Trabzon, Denizli, and Diyarbakir. Asthma was diagnosed in accordance with the Global Initiative for Asthma (GINA) criteria [11], and it included assessment of respiratory symptoms such as wheezing, shortness of breath, chest tightness or cough, and variable expiratory airflow limitation. We invited patients with asthma to participate in the study, regardless of their age or working status. Patients who provided written consent for participation were enrolled in the study. They completed a questionnaire administered by a physician.

The term “housewife” in this study covers female patients who have not been working in another job. The main tasks of housewives in Turkey are dealing with the home’s management (including cleaning) and organization.

**Questionnaire and Clinical Data**

Demographic data (sex, age, education level, occupation, and smoking history) and disease characteristics, such as asthma duration, history of childhood asthma, and atopy, were recorded by an investigator; and patients completed a standardized questionnaire. The questionnaire developed for this study was modified from existing validated questionnaires focusing on workplace exposure [12,13]. Our questionnaire included questions on the patients’ occupation, suspected or known exposures in the workplace, duration of asthma and length of employment, as well as inquiries into the relationship between asthma symptoms and workplace exposure, and, if present, details on rhinitis and conjunctivitis symptoms. The current occupation and exposure-symptom relationship in that workplace were recorded. For subjects working in more than two jobs, the main occupation in which the subject spends most of the time was selected. The questionnaire was modified to include additional items that were relevant to the Turkish population (Table 1).

**Spirometry and Allergy Testing**

We performed pulmonary function tests (forced expiratory volume in one second [FEV₁], forced vital capacity [FVC], peak expiratory flow [PEF]) and evaluated them according to the American Thoracic Society/European Respiratory Society (ATS/ERS) guidelines [14]. According to the GINA guidelines for the diagnosis of asthma, an FEV₁/FVC < 0.80 was accepted as airflow limitation [11].

Skin-prick tests were carried out with a standard panel of airborne allergens consisting of grass (Dactylis glomerata, Lolium perenne, Phleum pratense, Poa pratensis, Festuca pratensis), weed (Artemisia vulgaris, Urtica dioica, Taraxacum vulgare, Plantago lanceolata, Chenopodium album), mold (Alternaria alternata, Cladosporium herbarum, Aspergillus fumigatus) allergens, cat and dog dander, and house-dust mites (Dermatophagoides pteronyssinus and D. farinae). A wheal size larger than 3 mm was considered as a positive reaction.

**Table 1. The questionnaire**

| Question                                                        | YES | NO |
|-----------------------------------------------------------------|-----|----|
| Is there any relation between your asthma symptoms and your workplace? |     |    |
| Does your asthma become worse at workplace?                     |     |    |
| Did your asthma onset after starting employment?                |     |    |
| How long have you been working in this job?                    |     |    |
| How long after you’ve started your complaints arose?           |     |    |
| Do your symptoms improve during weekends/holidays?             |     |    |
| Do you expose to dust, fumes, or gases at work                 |     |    |
| Do you know the material?                                      |     |    |
| Is your workplace ventilated?                                  |     |    |
| Do you have respiratory protection devices?                    |     |    |
| Do you also have rhinitis symptoms?                            |     |    |
| Do your rhinitis symptoms become worse at workplace?           |     |    |
| Do you also have conjunctivitis?                               |     |    |
| Do your conjunctivitis symptoms become worse at workplace?     |     |    |
| Did you have intense exposure to chemicals, smoke, or dust within 24 hours of onset of worsening asthma? |     |    |
| Do you expose to cleaning supplies at home?                    |     |    |
| Do you use bleach?                                             |     |    |
| Do you use hydrochloric acid?                                  |     |    |
Data Management and Analysis

Two researchers extracted the data from the paper questionnaires and entered them into a secure password-protected electronic database. We compared differences between groups using the Student’s t-test for continuous variables and the Chi-square test for categorical and dichotomous variables using the Statistical Package for the Social Sciences software version 20.0 (SPSS IBM Corp.; Armonk, NY, USA), considering p-values <0.05 to be statistically significant. The median with interquartile range assessed nonparametric continuous variables, while mean±standard deviation evaluated parametric continuous variables. Analysis used counts and percentages when applicable.

RESULTS

The study enrolled 345 patients (188 females, 54%) with a mean age of 42±14 years (18–80). The median duration of asthma was 8.7±9.5 years, whereas the mean duration of current employment was 17.9±12.1 years. Among the study group, 52% (n=179) of patients had rhinitis, and 30% (n=105) described conjunctivitis symptoms. In the whole group, 20% (n=69) of patients were active smokers, 65.8% (n=227) had never smoked, and 14.2% (n=49) were ex-smokers. Table 2 shows the baseline characteristics of the patients. Skin-prick tests were performed in 141 patients, revealing atopy in 88 (62.4%) cases. The largest proportion of patients was housewives (36.8%). Other common occupations were office workers (6.7%), textile workers (4.1%), students (3.8%), hospital staff (3.5%), and cleaners (2.9%) (Figure 1).

Of all subjects, 85% (n=294) stated that they had a diagnosis of asthma after starting work, whereas 15% (n=51) had pre-existing asthma. In patients whose asthma began after starting work, the onset of asthma symptoms occurred after an average of 10 (5–20) years of working. The percentage of patients who described worsening of asthma during work was 35% (n=120), with 23% (n=80) of the subjects reporting improvement of asthma symptoms during weekends and holidays. Among patients with a history of increased symptoms in workplace, 100 (83%) developed asthma after starting work, while 20 patients (17%) had pre-existing asthma. Patients who reported increased symptoms in the workplace were mostly car painters, cleaners, farmers, and textile workers (Table 3). A total of 102 patients (30%) described an increase in rhinitis symptoms in the workplace, and 20% (n=70) of patients with asthma reported an increase in conjunctivitis symptoms during working days. Men reported workplace-related symptoms more frequently than women did (p=0.001). Patients who reported work-related symptoms of asthma

| Table 2. Characteristics of patients with asthma |
|-----------------------------------------------|
| Number of patients                            | 345 |
| Age (year) *                                  | 42±13 (18-80) |
| Female, n (%)                                 | 188 (55) |
| Smoking                                       |      |
| Current smoker, n (%)                         | 69 (20) |
| Ex-smoker, n (%)                              | 49 (14) |
| Never smoked, n (%)                           | 227 (66) |
| Smoking (pack-year)**                         | 10 (5–20) |
| Duration of asthma (years)**                  | 5 (2–11) |
| Employment duration (years)**                 | 17 (7–25) |
| Time after employment of onset of asthma (year)** | 10 (5–20) |
| Conjunctivitis, n (%)                         | 105 (30) |
| Rhinitis, n (%)                               | 179 (52) |
| FEV<sub>1</sub> %*                             | 76±22 |

*mean±standard deviation; **median (IQR); FEV<sub>1</sub>: Forced Expiratory Volume in one second

Figure 1. Distribution of occupations of patients with asthma

![Figure 1. Distribution of occupations of patients with asthma](image-url)
were younger than subjects who did not (p=0.018). In the group whose asthma symptoms increased during work, exposure to dust, fumes, and gases was higher than in the group whose symptoms did not increase (p=0.001). A higher number of patients with work-related symptoms than those without work-related symptoms described improvement in their asthma symptoms during weekends and holidays (p=0.001). The ratio of subjects who reported an increase in rhinitis and conjunctivitis symptoms during working periods was higher in the group with a history of work-related asthma symptoms (p=0.001). There was no difference between the two groups in terms of FEV1 (77.2±21.2% vs. 75.3±23.7%) or FEV1/FVC (74.6±11.7% vs. 73.9±11.9%) values (p>0.05) (Table 4).

Half of the patients (n=173) reported workplace exposure to any kind of dust, fume, or gas. Exposure to cleaning supplies at home was present in 43% of subjects. The most common agent was dust, followed by cleaning supplies, paints, detergents, welding fumes, hair dyes, animal dander, latex, and formaldehyde. When comparing symptoms between patients with and without workplace exposure to dust, fumes, and gases, we found that increases in symptoms of asthma (n=106 vs. n=14), rhinitis (n=76 vs. n=26), and conjunctivitis (n=50 vs. n=20) were higher in the group that reported exposure (p<0.001). This difference was most striking for asthma symptoms. Table 5 compares the exposures and symptoms of housewives to those of both men and women in other occupations. Among housewives (n=127), 12% described an increase in their asthma symptoms during housework. This rate was lower than that of men or women in other occupations (both of which were 48%) (p=0.001). Fewer housewives described exposure to dust, fumes, or gases, or improvement in symptoms during holidays; however, the frequencies of bleach and hydrochloric acid use among housewives were 60% and 34%, respectively, which was significantly higher than in other occupations. The FEV1/FVC ratio of housewives who frequently used hydrochloric acid (FEV1/FVC=71.5) was lower than that of non-users (FEV1/FVC=74.9) (p=0.024).

**DISCUSSION**

In this study, we found that asthma symptoms worsened during working hours in 35% of patients with an existing diagnosis of asthma. When housewives were excluded, the per-
percentage of patients with worsening symptoms during work hours increased to 48%. To our knowledge, this is the first multicenter study to investigate the association between the workplace and symptoms for adults with asthma in Turkey. Our findings show the potential impact of OA, including in-home exposures, on asthma in our adult population.

In this study, majority of patients developed symptoms of asthma after being employed; onset occurred after an average of 10 years in their working environment. Our results are in concordance with previous studies that reported a high ratio of working adults with current asthma who developed the condition after years of exposure to agents at work [15,16]. Although our findings show the development of asthma after starting work, it should be kept in mind that asthma may start during the individual’s working life, but it may not be caused by specific exposure in the workplace. On the other hand, 17% of the subjects of the group with a history of worsening asthma symptoms at workplace had pre-existing asthma who can be categorized as work-exacerbated asthma (WEA). Although diagnosing and differentiating correctly between OA and WEA is important, it is not easy. The general agreement that a patient with a previous diagnosis of asthma may develop OA, and that the concomitant onset of asthma associated with work does not rule out that it is a WEA, makes the situation more complex [17,18].

One-third of patients in this study reported worsening asthma during work that could be considered as work-related asthma. Likewise, a recent paper by Dudek et al. [13] showed that 65% of patients reported more severe symptoms of shortness of breath/wheezing/chest tightness at work. This ratio seems to be higher than our subjects’ symptom rates during work; however, we included patients in our study irrespective of their occupations. Though 12% of housewives reported symptom increase during housework, excluding them raised the rate of patients whose asthma symptoms worsened in the workplace to 48%, a rate comparable to the Dudek study. In a previous report from Turkey including 1400 patients with asthma, 7.2% reported “increase in asthma symptoms at work” [19]. This lower rate of workplace-related asthma may be because the majority of the patients in that study were female (75%); and increases in asthma may not have been recorded as work-related if the patient was a housewife. In addition to asthma symptoms, our patients described increased rhinitis and conjunctivitis symptoms during working periods, which seemed parallel to worsening asthma in the workplace. Rhinitis often accompanies or precedes lower respiratory symptoms in patients with OA [20]. Some have suggested that the presence of work-related rhinitis symptoms should be taken into consideration when evaluating patients for occupational asthma [18,21,22]. Our results agree with the literature’s common emphasis of the need for investigation of upper airways in patients with work-related asthma symptoms.

Assessments of patients with asthma-like symptoms and those with existing asthma should consider occupational risk factors. Several studies in Turkey have reported occupational asthma in hairdressers, auto repair workers, car painters, furniture workers, and healthcare workers [4-8]. Our results regarding exposures agree with previous reports. In a recent study that investigated risk of asthma in relation to occupation, Wortong et al. [16] reported that inorganic dust was the agent most significantly associated with asthma. Only one in seven employed adults with asthma discusses the possible role of work in their disease with their physician [22]. It seems likely that a similar proportion of patients in this study may not have spoken about dust or any other exposure they might have experienced if it had not been investigated by the questionnaire. We believe that physician recognition of work-related respiratory symptoms will help patients eliminate exposure to the substances exacerbating their illness. Professional and domestic cleaning has been associated with new-onset occupational asthma, as well as WEA and respiratory symptoms without asthma [9]. Some studies found higher asthma risks for home cleaners compared with other indoor cleaners [23,24]. A previous study reported that women employed in domestic cleaning with a recent history of asthma or chronic bronchitis experienced worsening of respiratory symptoms on workdays and on days in which they spent more time cleaning [25]. In light of these data, we decided to include housewives in the study and to enroll patients without making any occupational discrimination. We found that a small but significant group of housewives (12%) described an increase in their asthma symptoms during housework with exposure to cleaning materials at home. In professional cleaners, several studies have associated asthma symptoms with use of sprays and bleach, and waxing [24-26]. An epidemiologic study found use of bleach to be extremely common and consistently associated with respiratory symptoms, particularly with symptoms of asthma [27]. In agreement with these studies, our study found exposure to cleaning supplies at home to be very frequent (43%), as well as the use of bleach and hydrochloric acid among housewives. Surprisingly, bleach use was significantly more prevalent in housewives than in other working women. Furthermore, the FEV$_1$/FVC ratio of housewives who frequently used hydrochloric acid was lower than that of non-users. It is evident that asthmatic housewives in our population are

| Table 5. Comparison of housewives, females with other occupations, and males with regard to exposures |
|-----------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| Asthma becomes more severe at work             | Housewives n=127 n (%) | Females with other occupations n=61 n (%) | Males n=157 n (%) | p |
| Improvement of asthma during weekends/holidays | 15 (12) | 29 (48) | 76 (48) | 0.001 |
| Exposure to dust, fumes, or gases             | 9 (7) | 15 (25) | 56 (36) | 0.001 |
| Uses bleach at home                           | 29 (23) | 39 (64) | 105 (67) | 0.001 |
| Uses hydrochloric acid at home               | 76 (60) | 29 (48) | 38 (24) | 0.001 |
| Uses hydrochloric acid at home               | 43 (34) | 19 (31) | 18 (12) | 0.001 |
exposed to chemicals during housework; and physicians and patients should be aware that housewives experience “work-related asthma” due to such in-home exposures.

Our study has limitations that need to be considered. First, although the modified questionnaire was based on the National Institute for Occupational Safety and Health, it has not yet been validated [12]. However, we do not feel that this is an issue because the questions were clear and easily understandable. Second, the convenience sampling technique used in our study has the risk of identifying a population that is not representative of the larger Turkish population. Third, we lack the data about work change due to respiratory symptoms. However, by including seven regions in Turkey, and in particular including household exposures of housewives, we believe our study population is still very informative and likely representative of exposures experienced by the workforce in Turkey.

In summary, our study found that patients with asthma experience significant workplace exposures that exacerbate their symptoms. Limiting workplace exposure will lead to better asthma control. Housewives experience significant exposure that triggers allergic and asthma symptoms. Policymakers should seek ways to reduce dust and fume exposures in the workplace and provide adequate protective devices and environmental protections. It is important to raise awareness about the prevalence and risks of occupational (including in-home) exposures in asthmatic patients and physicians to minimize asthma triggers and exacerbations.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Ankara University (24-466; 14.01.2011).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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