

Short communication

Sensitization to sunflower pollen and lung functions in sunflower processing workers

Background: This study aimed to investigate whether exposure to sunflower pollen (*Helianthus annuus*) increases both sensitization and respiratory symptoms, and whether or not it affects lung functions in sunflower processing workers.

Methods: The largest sunflower processing factories in the Thrace region of Turkey participated in this study. Workers from the units directly exposed to sunflower seed enrolled as the study group ($n=102$) and workers who were not directly exposed to *Helianthus annuus* pollen ($n=102$) were the control group. Detailed questionnaires covering respiratory and allergic symptoms were completed, and skin prick tests and lung function tests were performed.

Results: We found a very high rate (23.5%) of sensitization to *Helianthus annuus* in the study group compared to the controls ($P<0.001$). Logistic regression analysis showed that the risk of sensitization to *H. annuus* was increased 4.7-fold (odds ratio = 4.17, 95% confidence interval = 1.3–16.7) if subjects were exposed to sunflower pollen in the workplace. While asthmatic symptoms and allergic skin diseases were not different between the two groups, workers in the study group had a higher rate of allergic rhinitis and conjunctivitis ($P<0.05$). We found that pulmonary function was significantly impaired in the study group ($P<0.01$). Using a multivariate analysis model, inclusion in the study group was found to be a predictive factor for impairment of lung function ($P=0.002$).

Conclusions: We conclude that sunflower pollen has high allergenic potential, especially when there is close contact, and exposure to sunflower pollen in the workplace can result in impairment in lung function.

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The sunflower (*Helianthus annuus*) belongs to the botanic family of Compositae. *H. annuus* (HA) is cultivated in large areas in many countries for industrial purposes. The sunflower has great economic importance because of its use in the food industry, both as a raw material for cooking oil production and for processing of its dried seeds. Sunflower seeds are widely used in the production of margarine and cooking and salad oils, as well as for food for livestock, birds and poultry (1–3). Despite the large area covered by sunflower plantations throughout the world and the risk of occupational allergy among people handling sunflower pollen, there have been only a few studies dealing with sensitization to this pollen in a large group. Allergy to sunflower pollen has already been reported by people handling sunflowers (4) or living near to

extensive plantations (1), or working in sunflower processing factories (5, 6). A case of occupational asthma and rhinitis caused by sunflower seed dust has also been reported (2).

This study aimed to investigate whether exposure to sunflower pollen increases sensitization to HA, causes allergic and respiratory symptoms, and affects lung functions in sunflower processing workers.

Material and methods

Study design

This is a cross-sectional study. Subjects working in seed extraction and oil-cake units of sunflower processing factories have a very high exposure to sunflower seed dusts. These units are enclosed structures with areas of 1000–1500 m³ where workers spend an 8 h-day. Of 138 subjects working in these factory units, 102 entered this study and were enrolled as the study group. For the control group, 102 workers were selected randomly from 155 workers from other parts of the factories not directly exposed to sunflower pollen (security persons, drivers, workers in the package units, etc.). All subjects had been

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working in the same part of the factory and living within the sunflower factory area for at least three years. Subjects who received immunotherapy were not included in the study.

Questionnaire

We developed a detailed questionnaire which was a modification on a previous one (7, 8). It included data on respiratory and allergic symptoms, demographic factors, family history of asthma, tobacco use, allergen exposures, medication use, work environment and working years, dwelling and living status. Respiratory symptoms in the questionnaire were: episodic shortness of breath; wheeze and cough within the last year. When there was at least one of these symptoms, the subject was considered to have a respiratory symptom. Work-related respiratory symptoms were defined as occurrence of these respiratory symptoms at work on at least one occasion. Allergic diseases such as rhinitis, conjunctivitis and skin disease (allergic urticaria or the Atopic Eczema/Dermatitis Syndrome (AEDS)) were covered (9) and considered to be present in subjects with a history of one of these symptoms. Work-related allergic symptoms were defined as occurrence of rhinitis, conjunctivitis or skin disease symptoms at work at least once. We defined current smokers as those who had smoked for at least one month; ex-smokers as those who had not smoked for at least one month; passive smokers as those living with a smoking person; non-smokers as those smoking one cigarette or less per day.

Skin prick tests

These were performed according to the recommendations of the Sub-Committee on Skin Tests of the European Academy of Allergology and Clinical Immunology. The grading system was based on the relation between the reactions induced by allergen and histamine reference (10). The allergens used together with histamine hydrochloride (10 mg/ml) and glycerol diluent controls were provided by Stallergenes S.A. (Antony, France) at concentrations of 1/10 IR (Index of Reactivity) for *DermatoPhagoides farinea*, *D. Pteronyssinus* and of 1/20 IR for grasses, cereals, trees, weeds and W/V (weight/volume) *H. annuus*.

Lung function tests

These were performed with a microspirometer (Microplus, Micromedical Ltd., Rochester, England).

Statistical Analysis

Statistical analysis was performed using SPSS 9.05. Chi-squared (χ^2) tests were used to compare differences in characteristics of the two groups. Three separate logistic regression analyses were performed to analyze the risk factors for *H. annuus* (HA) sensitization, respiratory and allergic symptoms. Dependent variables and covariates used in these logistic regression analyses were shown in Table 2. Student *t*-test was used for the comparison of lung function parameters between the two groups. Multivariate analyses were performed to analyze the predictive factors for impairment of lung function parameters. In the multivariate analysis model, we used forced expiratory volume in one second (FEV₁), FEV₁/FVC, forced vital capacity (FVC) and peak expiratory flow (PEF) parameters as dependent variables, age, gender, working years and tobacco use as covariates, and the group subjects belonged to as a factor. For significance we took *P*-values of less than 0.05.

Results

Two hundred and four workers (102 workers in the

study group and 102 in the control group) participated in this survey. Table 1 shows the characteristics of the workers.

Respiratory symptoms

Respiratory symptoms had been reported in 22 (21.6%) of the study subjects and 16 (15.7%) of the controls. Work-related respiratory symptoms were present in 17 (16.6%) of the study subjects and 7 (6.8%) of the controls. The difference was significant statistically ($P=0.048$). Family history of asthma was positive in 4.9% of the study group and in 5.8% of the controls.

Rhinitis and conjunctivitis

Rhinitis and conjunctivitis were significantly higher in the study group ($P<0.05$), but skin diseases were not statistically different between the groups. Work-related allergic symptoms were observed in 29 (28.4%) of the study subjects and 15 (14.7%) of the controls ($P=0.042$).

Skin prick tests

Skin prick tests revealed that 23.5% of study subjects were sensitized to HA. On the other hand in the control workers the rate of positive skin response to HA was 4.9% ($P<0.001$). We found significantly more skin test reactivity to other pollens in workers whose skin response to HA were positive ($P<0.0001$).

Logistic regression analysis

Logistic regression analysis showed that:

(a) The risk of the sensitization to HA was increased 19.3-fold in subjects who had a pollen sensitization when compared to subjects without a pollen sensitization.

(b) The risk of sensitization to HA was increased 4.7-fold in the study group when compared to control group.

(c) The risk of the sensitization to HA was increased 2.18-fold in smokers when compared to non-smokers.

(d) Smoking was appeared to increase the risk of respiratory symptoms 1.7-fold when compared to non-smokers.

(e) Duration of work was found to be a risk factor for allergic diseases (OR = 1.05) (Table 2).

Lung function

The means of FEV₁, FEV₁/FVC, FVC parameters were significantly lower in the study group ($P<0.01$) (Table 3). In the multivariate analysis model, being in the study group was found to be a predictive factor for impairment of lung function ($P=0.002$). Tobacco use and duration of work years were not found effective factors for this analysis model.

Table 1 Some characteristics and clinical features of workers

	Study Group	Control Group	P-value
Age (mean $\pm$ SD)	35.58 $\pm$ 7.95	33.36 $\pm$ 10.23	NS
Female	5(4.9%)	14(13.7%)	NS
Male	97(95.1%)	88(86.2%)	NS
Current smoker	67(65.7%)	54(52.9%)	NS
Ex-smoker	14(13.7%)	12(11.8%)	NS
Non-smoker	18(17.6%)	34(33.3%)	NS
Passive smoker	3(2.9%)	2(1.9%)	NS
Working years (mean $\pm$ SD)	11.2 $\pm$ 7.3	6.1 $\pm$ 5.8	<0.01
Sunflower positivity	24(23.5%)	5(4.9%)	<0.001
Mite positivity	8(7.8%)	9(8.8%)	NS
Pollen positivity	17(16.7%)	10(9.8%)	NS
Dyspnea	18(17.6%)	11(10.7%)	NS
Cough	12(11.8%)	7(6.9%)	NS
Wheeze	5(4.9%)	2(1.9%)	NS
Work-related respiratory symptoms	17(16.6%)	7(6.9%)	<0.05
Rhinitis	36(35.2%)	22(21.5%)	<0.05
Conjunctivitis	34(33.3%)	20(19.6%)	<0.05
Skin diseases	10(9.8%)	7(6.9%)	NS
Work-related allergic symptoms	29(28.4%)	15(14.7%)	<0.05
Ever have asthma/using asthma medication	4(3.9%)	6(5.8%)	NS
Family history of asthma	5(4.9%)	6(5.8%)	NS

Discussion

In this study a very high rate of sensitization to *H. annuus*, allergic rhinitis and conjunctivitis and impairment of lung function were found in sunflower processing workers compared to control workers.

There have been only a few reported studies dealing with sensitization to sunflower pollen (1, 2, 4–6, 11, 12). Jimenez reported that sunflower pollen should be considered not only as an occupational allergen but also an allergenic source in the general population living in sunflower growing areas (1). Zuskin assessed immunological changes in animal food processing workers and found a high rate of skin test positivity to sunflower (5).

Many occupational conditions involve in particular the skin, the nose, and the lungs (13). Vandenplas et al. reported a case of a baker who developed rhinitis and asthmatic reactions when exposed to sunflower seed dust at work (2). Bousquet reported a man who developed rhinitis, conjunctivitis and asthma over 5 years of exposure to sunflower pollen (4). Occupational

Table 3 Pulmonary functions of groups

Study group	Control group	P-value
FEV ₁ (L)	2.94 $\pm$ 0.68	3.20 $\pm$ 0.54 <0.01
FVC (L)	3.14 $\pm$ 0.72	3.32 $\pm$ 0.66 NS
FEV ₁ /FVC	93.44 $\pm$ 6.98	96.34 $\pm$ 7.01 <0.01
PEF (ml)	389.51 $\pm$ 130.34	436.88 $\pm$ 113.56 <0.01

Student's *t*-test

allergic contact dermatitis from sunflower has been reported as a case report (11, 12). Anaphylactic reactions have been reported after ingestion of commercial varieties of sunflower seeds (6).

Our results showed that incidence of respiratory symptoms and skin complaints were not different in sunflower processing workers and controls, but sunflower processing workers had a higher rate of allergic rhinitis and conjunctivitis. Moreover, when we considered all workers our results showed that a high number suffered from allergic and respiratory symptoms caused by sunflower pollen, but we did not find a difference in respiratory symptoms between the subjects exposed to HA and the controls. We thought that this could be the result of the high rate of sensitization in subjects living in the sunflower influence area (1).

Several factors contribute to the development of occupational asthma and allergies. The nature and concentration of inhaled substances and conditions within factories are important (13, 14). In general, the higher the level of exposure to the sensitizing substance, the higher the prevalence of occupational asthma and allergy (13). We also found that work-related respiratory and allergic symptoms were higher in the subjects who were exposed to sunflower pollens and dusts in the workplace than the control workers. In addition, logistic regression analysis showed that risk of sensitization to HA was increased 4.7-fold if subjects had been exposed to sunflower pollen in the workplace. Therefore we think that HA has a high allergenic potential especially when there is close contact.

Certain host factors also contribute to the development of occupational asthma and allergies. Smoking has been shown to increase the development of some

Table 2 Odds ratios (OR) indicating association of sensitization to HA, respiratory and allergic symptoms with tobacco use, working years, sensitization to mites, sensitization to pollens sensitization to HA and the group subjects belonged

Risk Factors	Sensitization to HA OR (p) 95%CI for OR	Respiratory symptoms OR (p) 95%CI for OR	Allergic symptoms OR (p) 5%CI for OR
Tobacco use	2.18 (0.032) (1.06–4.4)	1.7 (0.02) (1.07–2.72)	(NS)
Working years		(NS)	1.05 (0.007) (1.01–1.1)
Sensitization to mites		(NS)	(NS)
Sensitization to pollens	19.3 (<0.0001) (6.05–61.5)	(NS)	(NS)
Sensitization to HA		(NS)	(NS)
Being in the study group	4.7 (0.016) (1.3–16.7)	(NS)	(NS)

Logistic regression analysis (with Forward LR method). Odds ratios (ORs) of the risk factors that have a significant effect on statistical model are presented. OR is significant if confidence interval does not include 1.

sensitivities (13, 15, 16). In our study, smoking appeared to increase the risk of respiratory symptoms but it was not identified as a risk factor for sensitization to HA.

The nature of the sunflower seed allergen is not known. But it has been reported that this seed contains 2S albumin proteins that have, in other seeds such as cottonseed and walnuts, been associated with allergenicity (17). Further, de la Hoz has purified four allergens from *H. annuus* responsible for most allergic symptoms in sunflower sensitive patients (3).

Cross-reactivity between *H. annuus* allergen and other Compositae species is not very well documented. Jimenez et al. demonstrated the homology between sunflower and other Compositae pollen (1). Bousquet et al. found that sunflower allergens did not cross-react with ragweed allergen (4). However, Fernandez et al. suggested a high degree of allergenic homology between sunflower and mugwort (18). Hausen reported that cross-reactions were seen between sunflower and different Compositae species (19). Interestingly we found significantly more skin test reactivity to other pollens in workers who have positive skin response to HA, and we thought that this maybe due to cross-reactivity.

We could not find a large study in the literature dealing with pulmonary functions in workers exposed to sunflower pollen. Zuskin et al. assessed respiratory changes in animal processing workers, some of whom

had a sunflower sensitization, and they found significant reductions for all ventilatory capacity tests, particularly for forced expiratory flow at 25% of vital capacity (FEF25) (5). We found that pulmonary functions were significantly impaired in highly exposed workers. Additionally, our results showed that sensitization to sunflower pollen induced impairments in lung functions.

One of the limitations of this survey was the lack of measurements of specific IgE to sunflower pollen. However, considering the methodology used in the diagnosis of sensitization, namely skin prick tests and measurements of IgE, it seems evident that skin prick tests provide more reliable results for different allergens (20). Therefore, we think that our sensitization rates are highly reliable.

In conclusion, *H. annuus* has high allergenic potential especially when there is close contact. Such sensitization with this kind of contact results in an increased rate of allergic rhinitis and conjunctivitis. In addition, exposure to sunflower pollen in the workplace may not cause only allergic sensitization but may also induce impairment of lung function.

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