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Prevalence and Characteristics of Allergic Asthma in a Sample of Dairy Farmers

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Abstract

AIM: The objective of the study is to evaluate the prevalence characteristics of allergic asthma in a sample of dairy farmers.

METHODS: We performed a cross-sectional study including 83 dairy farmers (mean age: 52.6 ± 8.7 years; mean exposure duration: 23.7 ± 7.6 years) compared to 80 office controls (mean age: 52.7 ± 8.2 years) matched for age, smoking habits, and socioeconomic status. Methods of evaluating examined subjects included a questionnaire on respiratory symptoms in the past 12 months, baseline spirometry and histamine challenge, and skin prick tests to standard inhalant and occupational allergens.

RESULTS: The frequency of asthma was non-significantly higher in dairy farmers than in controls (7.2% vs. 5%). The frequency of allergic asthma was non-significantly higher in dairy farmers than in controls (6% vs. 3.8%). The frequency of allergic asthma was significantly higher compared to non-allergic asthma in both groups, while the frequency of subjects with allergic asthma who are sensitized to occupational allergens (wheat, corn, rye, cow hairs, molds) was similar in dairy farmers and controls. The risk of sensitization to occupational allergens was non-significantly higher among dairy farmers with allergic asthma (OR = 1,39 [0,18–12,28] CI 95%), compared to office controls. The risk for asthma development was non-significantly higher in subjects sensitized to occupational allergens compared to those who are not sensitized to them both in dairy farmers (OR = 2.00 [0.11–40.60] CI 95%) and office controls (OR = 3.00 [0.00–197.11] CI 95%). The risk for asthma development was about 4 times higher in subjects with atopy compared to those without atopy among dairy farmers (OR = 4.00 [0.22–104.88] CI 95%), while in office controls was almost identical (OR = 1.00 [0.00–39.77] CI 95%). Having in mind sensitization to certain inhalant allergens, asthma was significantly associated with sensitization to *Dermatophagoides pteronyssinus* both in dairy farmers ($p < 0.01$) and office controls ($p < 0.05$).

CONCLUSION: The results suggest that occupational exposure among dairy farmers was associated with a higher prevalence respiratory symptoms, lung function impairment, and allergic asthma development. Study findings also can contribute in the detection of critical points for action, predict asthma development, and indicate the need for reduction of adverse occupational exposures by appropriate preventive measures, use of respiratory protective equipment, and implementation of engineering controls.

Introduction

Lung diseases have been recognized among dairy farmers for decades. Studies of dairy farmers worldwide have shown increased rates of asthma, and consistently reported the presence of bronchial hyperresponsiveness (BHR), and increased symptoms of wheezing, cough, and chest tightness [1], [2], [3].

Respiratory diseases are still an important health problem for farmers since numerous studies demonstrate a significantly increased risk of respiratory morbidity and mortality. This risk exists despite relatively lower prevalence of smoking among farmers, compared to the general population, which only confirms the influence of occupational risk factors. Respiratory diseases in agriculture, considering the size of the affected population, represent a public health problem [4]. Common to the work tasks in animal husbandry are physical load, milking and shearing of sheep in a non-physiological body position, exposure to gases, low temperatures, and danger of injuries and zoonotic infections. In animal husbandry, workers are often exposed to dust of different compositions, hay particles, straw and other food ingredients of plant origin, animal hair and feces, spores, and fungi [5].

In modern farms, most of the activities are mechanized or semi-automated. Workers are exposed to high concentrations of ammonia and carbon dioxide, odors, physical exertion, low temperatures, infections, etc. Inflammatory changes in the respiratory system and other chronic respiratory diseases are common, and therefore, asthma is an important problem because many substances found on farms are known triggers and contributors to occupational asthma or work-exacerbated asthma [6].

Work on dairy farms has been associated with adverse respiratory symptoms, primarily symptoms of bronchoconstriction, and decreased pulmonary function [7], [8], [9], [10]. Dairy farmers may be at risk for lung inflammation due to the proximity of aerosol sources (e.g., cows) and exposure duration. In addition, dairy farm workers often work long shifts for more than 5 days a week performing the same or similar tasks (e.g., milking) [11]. These aerosols may contain a mixture of manure, animal dander, hair, animal feed, Gram-positive (muramic acid), and Gram-negative (endotoxins) microbiological components [10]. Chronic airway diseases developing from exposure to large animal-feeding operations include a spectrum of upper and lower respiratory tract disorders and commonly occur following exposure to large animal-feeding operation farming environments, particularly swine confinement facilities and commercial cattle feedlots [12].

Asthma is associated with large animal farming exposures. It was postulated that exposure to endotoxin or other bacterial components abundantly present in various farming environments leads to decreased IgE-mediated disease development [11], which is also consistent with the hygiene hypothesis.

Occupational respiratory hazards in farming can exacerbate existing or lead to new-onset asthma. Exposure to organic plant dust, e.g., cereal dust, may exacerbate existing asthma or cause new-onset occupational asthma. One of the most important public health problems in farming is respiratory diseases. Having in mind that exposure to most of the respiratory hazards in this sector can be controlled and/or reduced subsequently work-related respiratory diseases in dairy farmers caused by these agents are potentially preventable [6].

Objective of the study

The study objective was to assess the prevalence and characteristics of allergic asthma in a sample of dairy farmers and evaluate the role of job exposure and smoking as predictors for respiratory health impairment.

Subjects and Methods

Study design and setting

A cross-sectional study was carried out at the Center for Respiratory Functional Diagnostics within the Institute for Occupational Health, Skopje, during the period April 2019–February 2020, as a continuum of a bigger survey related to the workplace exposure to respiratory hazards, and lung function impairment among dairy farmers.

The study protocol was approved by the Institute's ethics committee, followed by a written consent by each examined subject previous to any involvement in the study.

Study sample

A software program PEPI 4.04 was used to calculate the representative study sample (95% confidence level and confidence interval ±5), evaluating the exposed group of 83 dairy farmers and 80 matched office controls employed in a large-scale agricultural enterprise. These particular groups were also analyzed by certain different aspects in our previous study [13].

Subjects

The actual study involved 83 subjects (mean age= 52.6 ± 8.7) employed as dairy farmers (mean duration of exposure 23.7 ± 7.6), with main tasks and activities in preparation of fodder feeding and animal meals, milking, work in the barn, straw preparation, hay making, cattle rising, and taking care about milk hygiene and animal health. They were exposed to various respiratory agents such as dust, inappropriate microclimate conditions, chemical hazards, vapors, and gases but also a heavy manual work, animal contact, unfavorable body positions, and repetitive hand movements. Inclusion criteria for examined group (EG): Employed subjects with age range 18–64 years involved in dairy farming and exposed to at least one occupational respiratory hazard (dust, gases, fumes, and vapors). To avoid selection bias and particular deviations in results, we did not include subjects with exposure to respiratory hazards other than dairy farming. Depending on the exposure duration the examined subjects were divided into two subgroups: Exposed less or more than 20 years.

Furthermore, similar group of 80 office workers (mean age = 52.7 ± 8.2) matched for age, duration of employment, daily smoking, and socioeconomic status was studied as a control group (CG), with no occupational exposure to respiratory hazards.

The subjects in both groups diagnosed by physician to have some chronic respiratory disorder (asthma, COPD, bronchiectasis, sarcoidosis, etc.) or treated with bronchodilators and/or corticosteroids were not included in the study. Also, we did not include any subjects in whom either spirometry or bronchodilator reversibility testing was contraindicated.

Questionnaire

Each study subject was interviewed by physician and completed the standardized questionnaire, including questions on work history, respiratory symptoms in the past 12 months, and smoking habit. Chronic respiratory symptoms in the past 12 months (cough, phlegm, dyspnea, wheezing, and chest tightness) were obtained using the European Community for Coal and Steel questionnaire, and the European Community Respiratory Health Survey questionnaire [14], [15].

Smoking status was evaluated using the World Health Organization guidelines [16]. Daily smoker was defined as a subject who smoked at the time of the survey at least once a day, except on days of religious fasting. Among daily smokers, lifetime cigarette smoking and daily mean of cigarettes smoked were also assessed. Pack years smoked were calculated according to the actual recommendations [17]. Ex-smoker was defined as a formerly daily smoker, who no longer smokes, while passive smoking or exposure to environmental tobacco smoke was defined as the exposure of a person to tobacco combustion products from smoking by others [18].

Skin prick tests (SPT) to standard inhalant and occupational allergens

The atopic status of subjects diagnosed with asthma was determined by SPT to standard inhalant allergens: Birch pollen (*Betula spp*), grass mixed pollen, tree mixed pollen, plantain (*Plantago lanceolata*), *Dermatophagoides pteronyssinus*, dog hair, cat fur, and feathers mixed. The sensitization to occupational allergens was evaluated by specific allergens related to dairy farming (wheat, corn, rye, cow hairs, molds, etc.).

SPT was performed on the volar part of the forearm using commercial allergen extracts (Torlak, Serbia). All tests had positive (1 mg/mL histamine) and negative (saline 0.9%) controls. SPT was considered positive if the mean wheal diameter 20 min after allergen application was at least 3 mm or larger [19].

Baseline spirometry

Each study subject underwent spirometry testing, performed by spirometer Ganshorn SanoScope LF8 (Ganshorn Medizin Electronic GmbH, Germany). Measured parameters included forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC ratio, and maximal expiratory flow at 50%, 75%, and 25–75% of FVC (MEF50, MEF75, and MEF25-75, respectively), by recording the best result from three measurements of the FEV1 values within 5% of each other. Results were reported as a percent of their predicted values due to the current European Respiratory Society (ERS) recommendations including reproducibility and acceptability [20].

Histamine challenge test

BHR was assessed by the histamine challenge test which was performed according to the actual ERS/American Thoracic Society recommendations [21], [22]. Concentrations of 0.5, 1, 2, 4, and 8 mg/mL histamine (Torlak, Serbia) were prepared by dilution with buffered saline. Afterward, the doses of aerosol generated by Pari LC nebulizer with output rate 0.17 mL/min were inhaled by examined subjects through mouthpiece. Study participants inhaled increasing concentrations of histamine using a tidal breathing method until FEV1 fell by more than 20% of its baseline value (provocative concentration 20 - PC20) or until reaching the highest concentration.

Diagnostic criteria for asthma

According to the actual recommendations by the Global Initiative for Asthma, asthma in subjects with normal spirometry findings is defined as symptomatic BHR with PC20 ≤ 4 mg/mL whereas in subject with certain respiratory impairment with positive bronchodilator test [23].

Statistical analysis

Data were analyzed by Statistica for Windows version 7. Continuous variables were expressed as mean values with standard deviation, while categorical variables as numbers and percentages. Examined variables were checked for normality by Kolmogorov–Smirnov and Shapiro–Wilk's W test. The Chi-square test (or Fisher's exact test) was used for testing differences in the prevalence of certain variables. A $p < 0.05$ was considered statistically significant.

Results

Table 1 gives an overview of overall and demographic characteristics of the study subjects.

Table 1: Demographics of the study subjects [13]

Variable	Dairy farmers (n = 83)	Office workers (n = 80)
Gender/M/F ratio	2.6	2.7
Age range (years)	20–63	21–64
Age (years)	52.6 ± 8.7	52.7 ± 8.2
BMI (kg/m^2)	25.4 ± 3.6	26.2 ± 3.7
Duration of employment (years)	26.3 ± 10.1	25.3 ± 9.8
Duration of exposure	23.7 ± 7.6	/
Daily smokers	39 (46.9%)	39 (48.7%)
Life-time smoking (years)	18.9 ± 7.6	19.2 ± 7.8
Cigarettes/day	14.6 ± 6.8	14.8 ± 7.2
Pack-years smoked	12.5 ± 4.8	12.9 ± 4.9
Ex-smokers	9 (10.8%)	12 (15%)
Passive smokers	7 (14%)	8 (16%)

Numerical data are expressed as mean value with standard deviation; Frequencies as number and percentage of study subjects with certain variables. BMI: Body mass index; kg: Kilogram; m: Meter.

The subjects of examined and CG reported neither diagnosis of any chronic respiratory non-occupational disease (sarcoidosis, tuberculosis) established before the study, nor treatment with oral corticosteroids, bronchodilators, antihistamines, or any other medications that could potentially influence the functional and clinical findings.

Table 2 gives an overview of the frequency of asthmatic symptoms (cough, dyspnea, wheezing, and/or chest tightness), positive histamine challenge tests with PC_{20}≤4 mg/mL, as well as asthma prevalence among subject in EG and CG.

Table 2: Frequency of asthma symptoms, positive histamine challenge tests with PC_{20} ≤ 4 mg/mL and asthma among subjects in EG and CG

Variable	EG (n = 83) (%)	CG (n = 80) (%)
Respiratory symptoms in the past 12 months	24 (28.9)	16 (20)
Positive histamine challenge tests with PC_{20} ≤ 4 mg/mL	7 (8.5)	5 (6.3)
Asthma	6 (7.2)	4 (5)

Data are given as number and percent of subjects with certain variable. EG: Examined group, CG: Control group.

The frequency of asthma was non-significantly higher in dairy farmers than in controls (Figure 1).

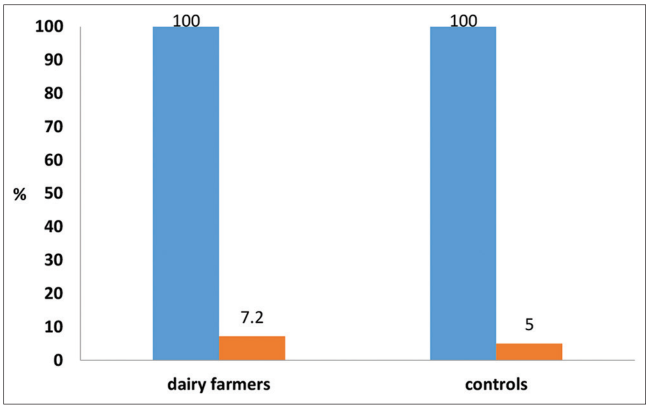

Figure 1: Frequency of asthma in dairy farmers and in controls

According to the Figure above, the risk for asthma development was non-significantly higher in dairy farmers (OR = 1.48 [0.35–6.55] CI 95%), compared to office controls.

The frequency of allergic asthma was non-significantly higher in dairy farmers than in controls (Figure 2).

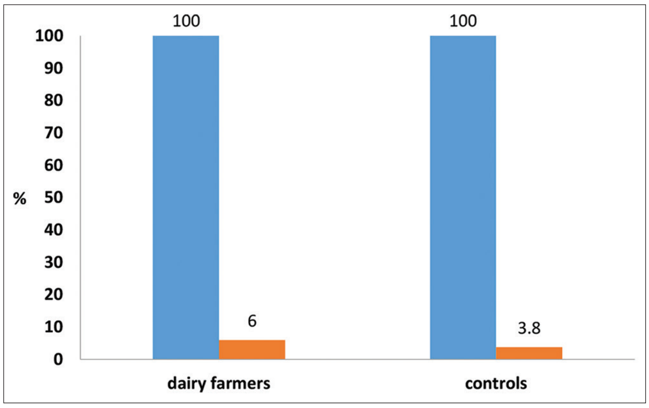

Figure 2: Distribution of allergic asthma among dairy farmers and office controls

According to the upper Figure, the risk for allergic asthma development was non-significantly higher in dairy farmers (OR = 1.65 [0.33–9.05] CI 95%), compared to controls.

The frequency of allergic asthma was significantly higher compared to non-allergic asthma in both groups (Figure 3).

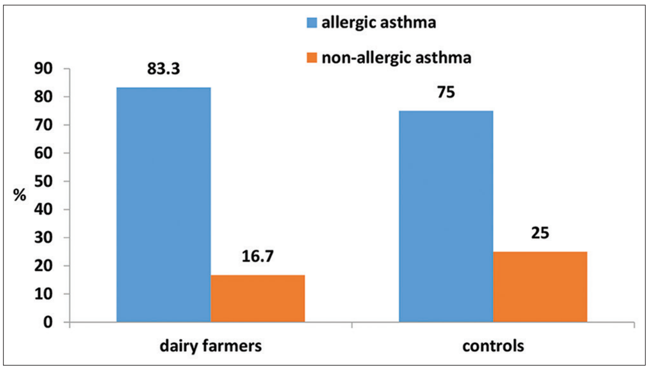

Figure 3: Distribution of allergic and non-allergic asthma in dairy farmers and controls

The frequency of subjects with allergic asthma who are sensitized to occupational allergens (wheat, corn, rye, cow hairs, molds) was similar in dairy farmers and controls (Figure 4).

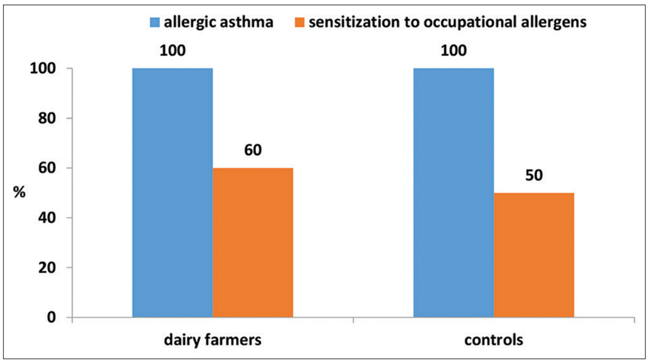

Figure 4: Frequency of sensitization to occupational allergens in subjects of examined group and control group with asthma

The risk of sensitization to occupational allergens was non-significantly higher among dairy farmers with allergic asthma (OR = 1.39 [0.18–12.28] CI 95%), compared to office controls.

Frequency of subjects sensitized to certain occupational allergens was non-significantly higher in dairy farmers with allergic asthma compared to controls (Figure 5).

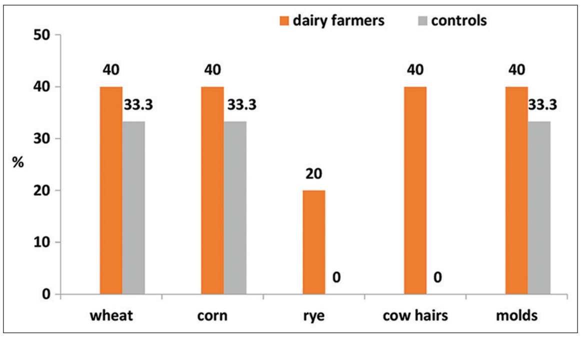

Figure 5: Sensitization to certain occupational allergens among subjects with allergic asthma in dairy farmers and controls

Frequency of subjects sensitized to standard inhalant allergens was non-significantly higher in dairy farmers with allergic asthma compared to controls (Figure 6).

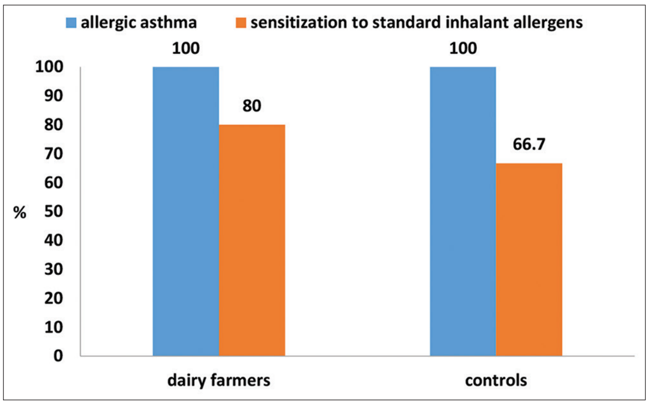

Figure 6: Frequency of sensitization to standard inhalant allergens in subjects of examined group and control group with asthma

The risk of sensitization to standard inhalant allergens was non-significantly higher among dairy farmers with allergic asthma (OR = 1.97 [0.30–16.03] CI 95%), compared to controls.

In dairy farmers with allergic asthma, the most common is sensitization to *D. pteronyssinus*, grass and tree mixed pollen, and birch pollen, while among control subjects with allergic asthma, the most common is sensitization to grass and tree mixed pollen, and *D. pteronyssinus* (Table 3). The difference in the frequency of sensitization to individual allergens in dairy farmers and office controls with allergic asthma was non-significant.

Table 3: Sensitization to certain allergens among subjects with allergic asthma in dairy farmers and office controls

Allergen	Subjects with allergic asthma	
	EG (n = 5) (%)	CG (n = 3) (%)
Birch pollen	3 (60)	1 (33.3)
Grass mixed pollen	3 (60)	3 (100)
Tree mixed pollen	2 (40)	2 (66.7)
Plantain pollen	1 (20)	0
Dermatophagoides pteronyssinus	4 (80)	2 (66.7)
Dog hair	2 (40)	1 (33.3)
Cat fur	1 (20)	1 (33.3)
Feathers mixed	1 (20)	0

Data are given as number and percent of subjects with certain variable. EG: Examined group, CG: Control group.

The association of asthma in dairy farmers and controls with sensitization to occupational allergens and atopy is shown in Table 4.

Table 4: Association of asthma with sensitization to occupational allergens and atopy

Variable	EG (n = 6) (%)	p*	CG (n = 4) (%)	p*
Asthma with sensitization to occupational allergens	3/6 (50)	NS	2/4 (50)	NS
Asthma without sensitization to occupational allergens	2/6 (33.3)	1,000	1/4 (25)	1.000
Asthma with atopy	4/6 (66.7)	NS	2/4 (50)	NS
Asthma without atopy	2/6 (33.3)	0,283	2/4 (50)	1.000

Data are given as number and percent of subjects with certain variable. *Tested by Fisher's exact test. EG: Examined group, CG: Control group.

The risk for asthma development is non-significantly higher in subjects sensitized to occupational allergens compared to those who are not sensitized to them both in dairy farmers (OR = 2.00 [0.11–40.60] CI 95%) and office controls (OR = 3.00 [0.00–197.11] CI 95%). The risk for asthma development is about 4 times higher in subjects with atopy compared to those without atopy among dairy farmers (OR = 4.00 [0.22–104.88] CI 95%), while in office controls is almost identical (OR = 1.00 [0.00–39.77] CI 95%).

Having in mind sensitization to certain inhalant allergens, asthma is significantly associated with sensitization to *D. pteronyssinus* both in dairy farmers ($p < 0.01$) and office controls ($p < 0.05$).

Association between asthma and exposure duration and active smoking is shown on Table 5.

Table 5: Association of asthma with exposure duration and active smoking

Variable	EG (n = 6) (%)	p**	CG (n = 4) (%)	p**
Asthma with exposure duration ≤ 20 years	4/6 (12.5)	NS	/	/
Asthma with exposure duration > 20 years	2/6 (5.1)	p = 0.248	/	
Asthma in active smokers	4/6 (66.7)	NS	3/4 (75)	NS
Asthma in non-smokers	2/6 (33.3)	p = 0.567	1/4 (25)	0.485

Data are given as number and percent of subjects with certain variable. **Tested by Fisher's exact test. EG: Examined group, CG: Control group.

The risk for asthma development in dairy farmers is non-significantly higher in subjects with exposure duration <20 years (OR = 4.00 [0.22–104.88] CI 95%), compared to those with exposure duration for more than 20 years.

The risk for asthma development is non-significantly higher in active smokers, both in dairy farmers (OR = 4.00 [0.22–104.88] CI 95%) and office controls (OR = 9.00 [0.19–1900.62] CI 95%).

Discussion

The asthma prevalence among dairy farmers in the actual study is 7.2%, which is non-significantly higher compared to office controls (5%). The obtained results are similar to the results of the multicenter study on allergic diseases in Macedonia by Minov *et al*. The prevalence of asthma in the mentioned study among all participants was 5.4%, 4.8% among office workers, and among workers with specific occupational exposure, the prevalence was 5.8%. The highest prevalence of asthma was registered among workers from pharmaceutical industry (8.7%), textile industry (7.2%), and among workers within production of paints and varnishes (6.2%) [24].

Within the framework of the ECRHS, two studies have been performed, in Spain and New Zealand, which investigate the influence of occupational exposure on the onset of asthma. A significantly higher risk for asthma compared to office workers was registered among farmers (OR = 4.16), while a non-significantly higher risk was registered among laboratory technicians, workers in the chemical and wood industry, car refinishers, and workers in rubber and plastic production. The risk of asthma in the set of food production workers other than bakers was non-significantly higher than office workers (OR = 1.83 CI 95% 0.32–8.34), similar to the results of the study by Kogevinas *et al*. and the current study [25]. The data on the highest risk for the occurrence of asthma in farmers are explained by the characteristic occupational exposure of farmers in New Zealand, that is, the specific mixture of numerous animal, plant, and synthetic allergens [26].

The association of asthma with sensitization to occupational allergens is insignificant in dairy farmers and controls. According to the results of the mentioned study by Kogevinas *et al*., the risk of asthma in subjects with specific occupational exposure is about three times higher in atopic subjects (defined as at least one positive finding of specific IgE to pollen weed, *Parietaria, Cladosporium, D. pteronyssinus,* and cat fur) compared to non-atopic subjects (OR =3.25) [25], [27]. Also, the results of the study by de Meer *et al*. with 1906 participants on the association of asthma in subjects with occupational exposure to organic and inorganic dust with atopy (detected by SPT of eight standard aeroallergens) and smoking indicate a significant relationship of asthma with atopy in those exposed to organic dust, which is why the authors suggest an interaction of atopy and exposure to organic dust in the development of asthma [28].

Asthma caused or worsened by occupational exposure is the leading respiratory disease diagnosed in developed countries [29]. Pre-existing asthma is usually exacerbated by exposure to dust or other substances in the agricultural settings [30]. Hazardous agents in agriculture can worsen existing or trigger new-onset asthma. Numerous hazards in farming are capable of causing occupational asthma. Exposure to plant parts, such as grain or cotton dust, is more likely to cause an asthma-like syndrome than asthma itself [31]. Among farmers, the possibility of sensitization to micro-mites from grain dust in barns and barns and the development of asthma has already been proven [32]. Animal protein can aggravate existing or cause new-onset asthma in agricultural workers. Epithelium from cows is one of the most important triggers of allergic asthma in farmers in Finland [33]. Grain dust mites are proven causes of asthma in agricultural workers [31]. Low concentrations of irritants may worsen existing asthma but usually do not cause new-onset asthma, whereas solvents, ammonia, welding fumes, pesticides, herbicides, and fertilizers may contribute to worsening airway obstruction in individuals with pre-existing asthma. Reactive airway dysfunction syndrome, a form of irritant-induced asthma, can occur after inhalation of high concentrations of agricultural gases or vapors, such as noxious ammonia vapors and nitrogen oxides [34].

In the actual study, the prevalence of allergic asthma in asthmatic dairy farmers is 83.3% and 75% in asthmatic controls which is similar to the literature data. Sensitization to *D. pteronyssinus* is most frequent among individual standard aeroallergens in the subjects from both groups. Similar results were obtained in the study by Minov *et al*. performed with participants from the general population in our country in 2003 [24]. Also, the importance of sensitization to *D. pteronyssinus* as a risk factor for the onset of asthma has been registered both in several local studies and in the global analysis of ECRHS data [35].

The annual rate of self-reported occupational asthma in Sweden was 80/million, and female poultry workers and livestock farmers had one of the highest rates at 602/million [36]. In France, older farmers had a higher prevalence of cumulative or current asthma [37]. The prevalence of the combination of wheezing and non-allergic BHR was significantly increased among farmers in New Zealand [26]. In Denmark, the prevalence of asthma was 5.5% among livestock farmers and 10.9% among pig farmers [38].

Chronic airway inflammation in individuals with asthma is known to be unrelated to the exposure duration [39]. In the actual study, we have registered non-significant association of asthma with exposure duration in dairy farmers, similar to the survey by Bohadana *et al*. exploring the association of asthma with specific occupational exposure to organic dust in farmers [40].

Among the subjects in both groups, a non-significant association of asthma with smoking was registered. Dairy farmers who are asthmatic and active smokers have significant association of asthma with the length of smoking, which may suggest an interaction of smoking with occupational exposure to respiratory hazards, considering that the combined joint effect of smoking, the length of smoking experience and the number of cigarettes smoked daily, significantly influence the occurrence of asthma in dairy farmers, while their influence in office controls is non-significant. In the study by Plaschke *et al*., a significantly higher risk for the occurrence of adult asthma was registered in active smokers regardless of their atopic status [41].

According to the study by Kogevinas *et al*., the risk of asthma in subjects with specific occupational exposure is significantly higher in smokers (OR = 1.86) when asthma is defined as BHR with wheezing in the last 12 months [25]. Omland *et al*. registered a significant association of asthma with smoking among farmers [42], while Bohadana *et al*., also among farmers, reported a non-significant association of asthma with smoking [40].

Finally, the actual study has certain limitations. First of all, the study has a relatively small number of subjects in the study groups, and the absence of ambient monitoring could be an obstacle for a clear relationship between occupational exposure and respiratory impairment among dairy farmers. In addition, testing with more types of allergens, as well as *in vitro* testing might offer a better understanding of sensitization to occupational allergens, followed by its implications for respiratory impairment, and development of allergic asthma in dairy farmers.

However, the current study has also its strength, translated into the research about the job exposure in farming and its consequently respiratory effects over dairy farmers.

Conclusion

The study findings revealed a higher prevalence of respiratory symptoms and spirometric changes in dairy farmers compared to controls. The frequencies of asthma and allergic asthma were non-significantly higher in dairy farmers than in controls. The frequency of allergic asthma was significantly higher compared to non-allergic asthma in both groups, while the frequency of subjects with allergic asthma who are sensitized to occupational allergens was similar in dairy farmers and controls. The risk of sensitization to occupational allergens was non-significantly higher among dairy farmers with allergic asthma, compared to office controls. The risk for asthma development was non-significantly higher in subjects sensitized to occupational allergens compared to those who are not sensitized to them in both groups. The risk for asthma development was about 4 times higher in subjects with atopy compared to those without atopy among dairy farmers, while in office controls were almost identical. Asthma was significantly associated with sensitization to *D. pteronyssinus* both in dairy farmers and office controls. The results suggest that occupational exposure among dairy farmers is associated with a higher prevalence respiratory symptoms, lung function impairment, and allergic asthma development. Study findings also can contribute in the detection of critical points for action, predict asthma onset, and indicate the need for reduction of adverse occupational exposures by appropriate preventive measures, use of respiratory protective equipment, and implementation of engineering controls.

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