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Original Scientific Paper

OCCUPATIONAL ASTHMA IN SUBJECTS OCCUPATIONALLY EXPOSED TO HERBAL AND FRUIT TEA DUST

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We performed a cross-sectional study to detect occupational asthma (OA) in 63 subjects occupationally exposed to herbal and fruit tea dust and in 63 corresponding controls. The evaluation included a questionnaire, skin prick tests to workplace and common inhalant allergens, spirometry, and histamine challenge test. The evaluation of the work-relatedness of asthma in the exposed workers was based on serial peak expiratory flow rate (PEFR) measurements and bronchoprovocation tests. We found a higher prevalence of respiratory symptoms in the exposed workers, whereas spirometric parameters were significantly lower. The prevalence of sensitisation to allergens and of bronchial hyperresponsivenss (BHR) did not differ significantly between the groups. The prevalence of asthma was also similar in both groups (8.0 % *vs.* 6.4 %; $P=0.540$). Work-relatedness of symptoms was reported by all asthmatic tea workers and by no control with asthma. Significant work-related changes in PEFR diurnal variations and in non-specific BHR, suggesting allergic OA, were found in one tea worker with asthma (1.6 %). No specific workplace agent causing OA in the affected subject was identified. None of the tea workers with asthma met the criteria for medical case definition of the reactive airway dysfunction syndrome (RADS). Our data confirm workplace exposure to herbal and fruit tea dust as a risk factor for OA.

KEY WORDS: *bronchial provocation tests, peak expiratory flow rate, skin prick test*

Occupational asthma (OA), defined as an asthma that is caused by exposure to an agent present at work, is a growing problem, becoming the most common occupational respiratory disease in many countries (1, 2). According to the actual knowledge, OA may be caused by immunological sensitisation (allergic OA) or by a single or multiple peak exposure to irritants (irritant-induced asthma) (3, 4). Studies of substance-specific risk help to identify or implicate particular substances as causative agents, but they generally focus on a limited number of agents, and therefore can not determine the full extent of asthma from workplace exposure. Studies focused on occupation-specific risk make up for this shortcoming, because many substances potentially cause OA, and it is difficult to characterise all substance-specific exposures (5).

Respiratory symptoms among tea processing workers (tea workers) have been reported since the 1920s, whereas the first documented case of occupational asthma was published in 1970 (6). By now, only a few cases of allergic OA caused by inhalation of tea dust have been reported (7-9). Reactive airway dysfunction syndrome (RADS) in tea workers has also been described (10). This article presents our findings of OA in a group of subjects occupationally exposed to herbal and fruit tea dust, and is a continuation of our study on exercise-induced bronchoconstriction and respiratory symptoms in the same subjects (11).

SUBJECTS AND METHODS

Study design

This cross-sectional study was carried out at the Institute of Occupational Health, Skopje -WHO Collaborating Center from June 2003 to September 2005. OA was detected in a group of herbal and fruit tea processing workers, whereas a group of unexposed workers served as control. Two methodological approaches were used; the first applied to all subjects (questionnaire, SPT to workplace and common inhalant allergens, spirometry, and histamine challenge); and the second included additional investigations in the asthmatic tea workers (serial PEFR measurement and serial non-specific bronchoprovocation testing).

Subjects

The exposed group included 63 subjects (36 men and 27 women, aged 36-55) employed in a herbal and fruit tea processing plant. Their duration of employment ranged from 3 years to 30 years, mean duration (12.2±7.9) years (≤11 years 64.1 % of the employees; ≥12 years 35.9 %). According to the European Community Respiratory Health Survey (ECRHS), herbal and fruit tea processing is classified among "Other food processors", occupations that have a risk of OA (12).

The control group consisted of an equal number of office workers. According to the ECRHS classification, they were belong to the set of "Remainder professional, administrative, clerical, and service workers", that is, occupations that have no risk of OA.

Neither group had a subject with asthma diagnosed by a physician. Furthermore, neither group had a subject in whom histamine challenge was contraindicated (13, 14), or a subject with upper respiratory viral infection within three weeks before the histamine challenge test and serial peak expiratory flow rate (PEFR) measurement were performed. None of the subjects had been taking asthma medications or antihistamines for at least one month before the challenge test, serial PEFR measurement, and skin prick test.

Questionnaire

Respiratory symptoms in the previous 12 months (wheezing, shortness of breath, chest tightness, cough, and asthma attacks) were documented using the ECRHS screening questionnaire (15). Symptomatic subjects were asked about the onset (before or after entering the actual workplace) and work-relatedness of the symptoms (worsening of the symptoms during or after work shifts and improvement over weekends and holidays).

Detailed smoking history, family history of asthma (taking into account first-degree relatives), accompanying disease, and medication use were also evaluated.

Skin prick tests

Skin prick tests (SPT) to workplace allergens were performed on the volar part of the forearm using allergen extracts (Torlak, Serbia and Montenegro) of lime (5000 PNU), mugwort (5000 PNU), mixed fungi (*Alternaria alternata, Aspergilus fumigatus, Mucor, Penicillium notatum, Cladosporium herbarum, Candida albicans*, and *Trychophyton*; 4000 PNU), peach (1:20 w/v), and strawberry (1:20 w/v). The allergens were selected to match actual herbs and fruit used in tea processing and their confirmed fungal contaminants. All tests included positive (histamine 1 mg mL^{-1}) and negative (saline 0.9 %) controls. Skin prick tests were considered positive if the mean wheal diameter 20 min after allergen application was at least 3 mm larger than the size of the negative control (16).

Skin-prick-test positivity, defined as the presence of positive SPT reaction to common inhalant allergens (17), was assessed with SPT to birch (5000 PNU), mixed grass (*Agrostis alba, Alopecurus pralensis, Dactylis glomerata, Festuca pranesis, Phleum pratense, Poa pratensis, Secale cereale, Triticum aestivum,* and *Zea mais*; 5000 PNU), plantain (5000 PNU), *Dermatophagoides pteronyssinus* (4000 PNU), dog hair (4000 PNU), cat fur (4000 PNU), and mixed feathers (chicken and duck feathers; 4000 PNU) (Torlak, Serbia and Montenegro).

Spirometry

Spirometry, including measurements of forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), FEV_1/FVC ratio, maximal expiratory flow at 50 %, 25 % and 25 % to 75 % of FVC (MEF_{50}, MEF_{25} and MEF_{25-75}, respectively), were taken using spirometer Ganshorn SanoScope LF8 (Ganshorn Medizin Electronic GmbH, Germany) in all subjects, and the best of three measurements was recorded. The results were expressed as percentages of

predicted values set by the European Community for Coal and Steel (ECCS) norms (18).

Histamine challenge

Histamine challenge tests were performed in all subjects according to recommendations by the European Respiratory Society (ERS) / American Thoracic Society (ATS) (12, 13). Histamine (Torlak, Serbia and Montenegro) concentrations of 0.5 mg mL^{-1}, 1 mg mL^{-1}, 2 mg mL^{-1}, 4 mg mL^{-1}, and 8 mg mL^{-1} were prepared by dilution with buffered saline. Aerosol doses generated by Pari LC nebulizer (Pari GmbH, Germany) were inhaled through a mouthpiece. The subjects inhaled increasing concentrations of histamine using a tidal breathing method until FEV_1 fell by more than 20 % of its base value (provocative concentration 20, PC20) or the highest concentration was reached. According to the ATS recommendations, bronchial hyperresponsiveness (BHR) was categorised as moderate to severe BHR (PC20 < 1.0 mg mL^{-1}), mild BHR (PC20 = 1.0 mg mL^{-1} to 4.0 mg mL^{-1}) and borderline BHR (PC20 > 4.0 mg mL^{-1}). The test was considered positive if PC20 was equal or less than 4 mg mL^{-1} (13).

Asthma diagnosis

Subjects were considered having current asthma if they had symptoms suggestive of asthma in the previous 12 months and had positive histamine challenge according to the Global Initiative for Asthma (GINA) and ATS recommendations (14, 19).

Serial PEFR measurement

Serial PEFR measurements were performed in asthmatic tea workers using a PEFR-meter asmaPLAN+ (Vitalograph Ltd, Ireland) according to the ERS recommendations (1, 20). To provide an adequate representation of days at work and days away from work, positive record included two weeks at work and two weekends away from work, and negative record included two work periods separated by at least 10 days away from work.

Serial PEFR measurement was carried out by workers who were instructed how to use the PEFR-meter. They were instructed to take three readings and record the highest reading only if the two best readings were within 20 L min^{-1} apart. Readings were taken four times a day at similar times at work and away from work. The readings were interpreted by analysing diurnal PEFR variations. The test was considered positive when PEFR varied 20 % or more (calculated as maximum PEFR minus minimum PEFR divided by maximum PEFR) during working days, as opposed to days off.

Serial nonspecific bronchoprovocation testing

Serial histamine challenge was performed in asthmatic subjects of the exposed group on a work day and then non-specific BHR was reassessed after at least two weeks away from work. The test was considered positive when BHR improved by at least two doubling concentrations of histamine while away from work (21, 22).

OA diagnosis

Occupational asthma was diagnosed according to the criteria for medical case definition of OA proposed by the American College of Chest Physicians (ACCP) (22). The subjects were considered having allergic OA in the cases of diagnosed asthma (A), onset of symptoms after entering the workplace (B), association between symptoms of asthma and work (C), workplace exposure to an agent or process known to give rise to OA (D1), and significant work-related changes in PEFR (D2) or significant work-related changes in non-specific bronchial responsiveness (D3). The medical case definition of RADS included criteria A, B, C, D1 and D5 (onset of asthma with a clear association with symptomatic exposure to an irritant at the workplace).

Environmental measurements

Airborne vegetable dust was sampled on site during the eight-hour work shift. An APA 30 sampler (Hygitest, Bulgaria) was used to estimate total dust exposure using the gravimetric method. In addition, respirable fraction (particles with size less than 5 μm) was determined using the photometric method with a MINIRAM PDM-3 device (GCA Corporation, USA). Temperature and relative air humidity were measured using a Testo 400 (Testo, Germany). The data obtained were presented as minimal, maximal, and mean values.

Statistical analysis

Continuous variables were expressed as mean values with standard deviation (SD) and nominal variables as numbers and percentages. The chi-square test (or Fisher's exact test where appropriate) was used for testing difference in prevalence. Mean

spirometric values and mean diurnal PEFR variations were compared using the independent-samples *t*-test. A P-value below 0.05 was considered statistically significant. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 11.0 for Windows.

RESULTS

Characteristics of the study subjects are given in Table 1. The prevalence of overall respiratory symptoms in the previous 12 months was not significantly higher in tea workers than in controls. A significantly higher prevalence of respiratory symptoms in tea workers was related to the shortness of breath (Table 2). Work-related worsening of symptoms was reported by 78.3 % (18/23) of tea workers with respiratory symptoms. None of the symptomatic controls reported work-related changes in the symptoms.

The prevalence of positive SPT to workplace allergens was not significantly different between the tea workers and controls (24 % *vs.* 19.2 %; P=0.382; chi-square test). The highest prevalence of positive SPT was obtained for lime in both tea workers (19.2 %) and controls (12.8 %) (Figure 1).

The prevalence of positive SPT to common inhalant allergens was similar in tea workers and controls (28.8 % *vs.* 25.6 %, P=0.783; chi-square test). The highest prevalence of positive SPT in both examined groups was obtained for *Dermatophagoides pteronyssinus*, birch, and mixed grass (Table 3).

Mean spirometric parameters (FVC, FEV_1, FEV_1/FVC%, MEF_{50}, MEF_{25}, and MEF_{25-75}) were significantly lower in tea workers (Table 4).

The prevalence of BHR was non-significantly higher in tea workers (19.2 % *vs.* 12.8 %; P=0.414; chi-square test). Table 5 shows the prevalence of BHR in tea workers and controls by category.

According to the criteria described in Subjects and methods (presence of symptoms suggestive of asthma and positive histamine challenge), asthma was diagnosed in five (8.0 %) tea workers and in four (6.4 %) controls, and the difference was not statistically significant (P=0.540; chi-square test).

Work-related worsening of symptoms was reported by all asthmatic tea workers and by no control with asthma. As herbal and fruit tea processing is known to give rise to OA (6-12), we evaluated tea workers with asthma for OA using serial PEFR measurements and serial bronchoprovocation testing. Table 6 shows mean diurnal PEFR variations in the asthmatic tea workers on days at and away from work. There was

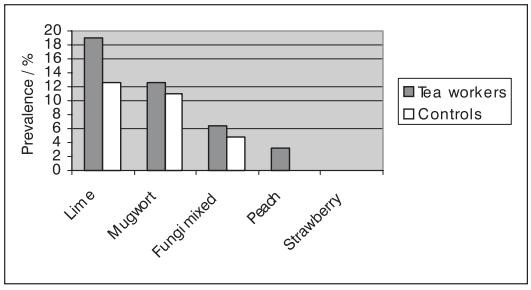

Figure 1 *Prevalence of positive skin prick tests to seven workplace allergens in tea workers and controls: lime 19.2 % vs. 12.8 %; mugwort 12.8 % vs. 11.2 %; fungi mixed 6.4 % vs. 4.8 %; peach 3.2 % vs. 0.0 %; strawberry 0.0 % vs. 0.0 %. Statistically non-significant difference in the prevalence of positive skin prick tests to workplace allergens between the two groups*

Table 1 *Characteristics of the study subjects*

Variable	Tea workers (n=63)	Controls (n=63)
Sex / M/F ratio	1.3	1.3
Age / yrs	45.6±5.5	45.8±6.1
BMI / kg m^{-2}	26.5±3.7	27.7±3.8
Positive family history of asthma	6 (9.6 %)	7 (11.2 %)
Daily smokers	25 (40.0 %)	20 (32.0 %)
Smoking experience / yrs	18.7±6.1	16.4±6.2
Cigarettes per day	22.2±9.8	19.3±10.2
Ex-smokers	5 (8.0 %)	7 (11.2 %)
Passive smokers	9 (14.4 %)	11 (17.6 %)

Numerical data are expressed as means with standard deviations; the frequencies of positive family history of asthma, active smoking, ex-smoking and passive smoking as number and percentage of subjects with certain variable.
M: male; F: female; BMI: body mass index.

Table 2 *History of respiratory symptoms in tea workers and controls within 12 months before the beginning of the study*

Respiratory symptoms in the previous 12 months	Tea workers (n=63)	Controls (n=63)	*P*-value *
Any respiratory symptom	23 (36.8 %)	16 (25.6 %)	0.156
Cough	19 (30.4 %)	12 (19.2 %)	0.084
Shortness of breath	15 (24.0 %)	6 (9.6 %)	0.032
Wheezing	11 (17.6 %)	6 (9.6 %)	0.192
Chest tightness	6 (9.6 %)	4 (6.4 %)	0.510
Asthma attacks	7 (11.2 %)	5 (8.0 %)	0.758

Data are expressed as number and percentage of subjects with certain variable.
** Tested by chi-square test.*

Table 3 *Prevalence of sensitisation to common inhalant allergens in tea workers and controls*

Allergen	Tea workers (n=63)	Controls (n=63)	*P*-value *
Birch	10 (16.0 %)	9 (14.4 %)	0.449
Grass mixed	10 (16.0 %)	11 (17.6 %)	0.573
Plantain	8 (12.8 %)	7 (11.2 %)	0.721
Dermatophagoides pteronyssinus	11 (17.6 %)	9 (14.4 %)	0.692
Dog hair	3 (4.8 %)	2 (3.2 %)	0.821
Cat fur	2 (3.2 %)	2 (3.2 %)	0.937
Feathers mixed	1 (1.6 %)	2 (3.2 %)	0.756

Data are expressed as number and percentage of subjects with certain variable.
** Tested by chi-square test.*

Table 4 *Spirometry findings in tea workers and controls*

Spirometric parameter*	Tea workers (n=63) Mean±SD	Controls (n=63) Mean±SD	P–value #
FVC / % pred	95.4±10.5	103.4±9.8	0.000
FEV_1 / % pred	88.4±8.7	97.3±9.2	0.000
FEV_1/FVC / %	75.6±4.5	79.2±3.1	0.000
MEF_{50} / % pred	68.9±10.7	90.5±11.9	0.000
MEF_{25} / % pred	58.0±9.5	81.0±11.0	0.000
MEF_{25-75} / % pred	81.1±16.7	104.5±12.9	0.000

** FVC: forced vital capacity; FEV_1: forced expiratory volume in 1 second; MEF_{50}, MEF_{25}, MEF_{25-75}: maximal expiratory flow at 50 %, 25 %, and 25-75 % of FVC, respectively; % pred: % of predicted value.*
 # Compared by independent-samples t-test.

Table 5 *BHR in tea workers and controls by category*

BHR category*	Tea workers (n=63)	Controls (n=63)
Moderate to severe BHR	2 (3.2 %)	/
Mild BHR	4 (6.4 %)	4 (6.4 %)
Borderline BHR	6 (9.6 %)	4 (6.4 %)

Data are expressed as number and percentage of subjects with certain variable.
BHR: bronchial hyperresponsiveness.
** Moderate to severe BHR: PC20<1.0 mg mL^{-1}; mild BHR: PC20=1.0-4.0 mg mL^{-1}; borderline BHR: PC20>4.0 mg mL^{-1}.*

Table 6 *Mean diurnal PEFR variations in tea workers with asthma on days at and away from work*

	PEFR / %		
Subject	Days at work	Days away from work	P*
1	27.2	11.8	0.001
2	18.5	15.4	0.093
3	15.5	17.6	0.112
4	23.4	20.4	0.306
5	19.6	16.2	0.403

** Tested by independent-samples t-test.*

Table 7 *PC20 in tea workers with asthma on a day at and away from work*

	PC20 / mg mL^{-1}	
Subject	Day at work	Day away from work
1	0.5	4
2	0.5	1
3	2	2
4	4	4
5	4	4

Table 8 *Diagnostic criteria for the diagnosis of OA in tea workers with asthma*

Subject	A	B	C	D1	D2	D3	D5
1	+	+	+	+	+	+	-
2	+	+	+	+	-	-	-
3	+	-	+	+	-	-	-
4	+	-	+	+	-	-	-
5	+	-	+	+	-	-	-

A: diagnosis of asthma; B: onset of symptoms after entering the workplace; C: association between symptoms of asthma and work; D1: workplace exposure to an agent or process known to give rise to occupational asthma; D2: significant work-related changes in peak expiratory flow rate; D3: significant work-related changes in non-specific bronchial responsiveness; D5: onset of asthma clearly associated with symptomatic exposure to an irritant at the workplace.

Table 9 *Environmental measurements at the tea processing plant*

Measurement	Mean±SD	Range	Limit value
Respirable dust / mg m^{-3}	3.1±0.8	1.9-4.4	3.0
Air humidity / %	41.0±4.6	37.0-45.0	40.0-75.0
Temperature / °C	20.5±0.6	20.0-21.0	17.0-22.0

one subject (Subject 1) with a significant difference in mean diurnal PEFR variations on the days at and away from work. The plot of maximum, mean and minimum PEFR in Subject 1 is shown in Figure 2. Serial bronchoprovocation testing of the tea workers with asthma showed improvement of BHR greater than at least two doubling concentrations in the same subject (Table 7). Positive and negative criteria for OA diagnosis in tea workers with asthma is shown Table 8.

The criteria for the medical case definition of allergic OA (A+B+C+D1+D2 or D3) were met by one asthmatic tea worker (Subject 1). The prevalence of subjects with significant work-related changes in bronchial BHR in the group of exposed workers was 1.6 %.

Subject 1 was a 45 year old male daily smoker with positive family history of asthma and positive SPT to mixed grass, *Dermatophagoides pteronyssinus*, and dog hair but negative SPT to workplace allergens. He had been employed in herbal tea manufacture for 10 years, and before that had worked as a guard in local administration for 12 years. He reported cough with shortness of breath and wheezing that was

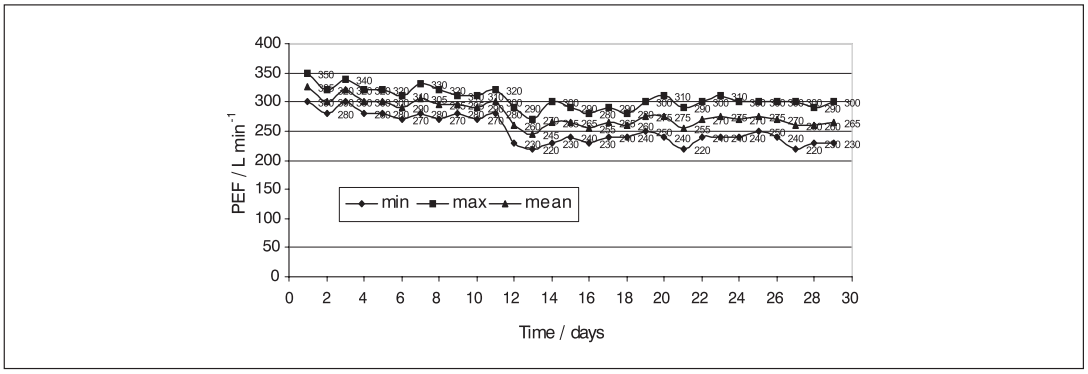

Figure 2 *Plot of maximum, mean and minimum peak expiratory flow rate (PEFR) against time showing significant changes in the diurnal PEFR variations on the days away from work (mean value 11.8 %) and days at work (27.2 %). Days away from work 1–10, days at work 12-29*

more pronounced during and after work shifts with symptom-free periods over weekends and holidays. The symptoms occurred approximately two years after taking the current position at the tea plant. Until this study, he was diagnosed chronic bronchitis and would receive antibiotics, inhalant salbutamol and/or oral theophylline as the symptoms would worsen.

None of the tea workers with asthma met the criteria for the medical case definition of RADS (A+B+C+D1+D5).

Data from environmental measurements suggested that workers employed in tea processing were exposed to respirable dust concentrations slightly over the national standards for organic dust and to relative air humidity that inclined towards the lower limit (Table 9).

DISCUSSION

Occupational exposure may reactivate asthma in individuals who have been asymptomatic for years, may aggravate pre-existing asthma, or may cause asthma in a healthy subject. OA accounts for at least 10 % of all asthma cases in adults (24). On the other hand, many affected individuals remain undiagnosed, as to diagnose OA is one of the most difficult procedures in respiratory medicine because of a large number of potential asthma-inducing agents, an extremely diverse range of materials and processes that are involved at the workplace, and individual variability in the time of pulmonary response to exposure (25, 26).

We studied OA occurrence in a group of subjects aged 35-55, exposed to vegetable dust and air humidity with borderline values regarding the national standards. Controls consisted of an equal number of unexposed subjects. Demographic characteristics were similar in both groups. A large proportion of daily smokers found in both groups was similar to the one documented in our earlier studies (27). We found a low number of ex-smokers in both groups, which suggests that not enough is being done to encourage people to stop smoking.

We found higher prevalence of respiratory symptoms in the exposed workers with individual respiratory symptoms within the range of published data about workers exposed to herbal and black tea dust (28, 29). Work-related worsening of the symptoms was reported by most symptomatic exposed workers.

Both groups showed a similar prevalence of positive SPT to workplace allergens, probably because these plants are widely distributed across non-occupational environments. There was a slight difference between the groups in sensitisation to lime, but it did not reach statistical significance. Similar data were reported by several studies that assessed sensitisation to workplace allergens in tea workers. In a study with workers processing dried fruits and teas, Žuškin et al. (9) reported significant difference in sensitisation to workplace allergens (tested by SPT) only for sage, whereas sensitisation to other allergens (chamomile, dog rose, pineapple, lemon, orange, peach, and apple) was not significantly different between exposed workers and controls. Similarly, Abramson et al. (29) in a study with packers of black and herbal teas reported low prevalence of sensitisation to tea varieties (black tea, chamomile, and lemon), tested by the radioallergosorbent test (RAST) and enzyme-linked

immunosorbent assay (ELISA), with no significant relationships between detectable tea-specific IgE and either work-related symptoms or lung function.

The prevalence and the pattern of allergic sensitisation to common aeroallergens in both the exposed and unexposed subjects was comparable to that we had previously observed among adults in Macedonia (30, 31).

Spirometric parameters were lower in the exposed workers, which confirms the constricting effect of tea dust mostly in the small airways, as reported by several studies with workers exposed to tea dust (6, 28, 32).

Data from studies that assessed BHR prevalence in workers exposed to airborne pollutants vary depending on the type, severity, and duration of exposure, subject characteristics, and study design. In a cross-sectional study including 3044 never-smokers with exposure to dusts, fumes, vapours, gases, and aerosols, Leuenberger et al. (33) found non-significantly higher BHR prevalence than in unexposed controls, with a greater adverse effect of dusts and fumes. Our study also showed a non-significantly higher BHR prevalence in tea workers than in controls. Literature lacks data about BHR prevalence in tea workers, whereas studies that assessed BHR prevalence in workers exposed to organic dusts produced different results (34, 35).

Similar prevalence of asthma in both groups was comparable to what we observed earlier among 722 adults aged 20-44 from six community health centres in Macedonia (27). None of the subjects with asthma from either group had a previous diagnosis of asthma, which confirms under-diagnosing of the disease documented by a number of studies (36, 37).

Work-related changes of the symptoms were reported by all the exposed workers with asthma and by none of the unexposed subjects with asthma. Pre-existing symptoms were reported by three exposed subjects with asthma, whereas in two subjects symptoms appeared after entering the actual workplace.

Herbal and fruit tea processing is known as an occupation with a risk for OA, so we evaluated to what extent was the disease work-related in tea workers with asthma. Even though it may produce false positive and false negative results, the specific inhalation challenge (SIC) with suspected workplace agent is considered as a gold standard in OA diagnostics (38). However, we were unable to perform SIC with tea dust, and assessed the work-relatedness of the disease using serial PEFR measurements and serial bronchoprovocation testing instead. Serial PEFR measurement is considered as more reliable in monitoring work-related pulmonary function changes than pre- and post-shift spirometry (38). Compared to SIC, PEFR is highly specific and sensitive (over 80 %) (20, 21, 40). As some authors (41) reported lower specificity and sensitivity of the serial PEFR measurement, we reassessed the work-relatedness of asthma using the serial bronchoprovocation test. Significant work-related changes suggesting allergic OA were documented by both techniques in the same subject, which confirms the conclusion of Côté et al. (42) that the combination of serial PEFR measurement and serial measurement of BHR does not add anything in allergic OA diagnostics to monitoring by PEFR alone. The prevalence of allergic OA in the group of herbal tea workers was 1.6 %, which was comparable to prevalences reported in the studies of Žuškin et al. (28) and Abramson et al. (29) (in both studies significant work-related changes in airway calibre were assessed by pre- and post-shift spirometry).

Just as Cartier et al. (8) and Abramson et al. (29), we did not detect the causative agent of OA. In fact, agents responsible for OA among herbal and fruit tea processors have still not been identified. Shirai et al. (43) suggested that epigallocatechin gallate (EGCG) could be the causative agent of green tea-induced asthma. As the examined plant did not process green tea, we did not include EGCG in the tested workplace allergens. We could speculate that causative agent could be other tea variety that was not tested, microbiological contamination other than the tested or, as Mapp (44) suggested, sensitisation occurred through interaction of different agents.

This study had some limitations. A relatively small size of the examined groups could have certain implications on the data obtained and their interpretation. Testing with more tea varieties, and in vitro testing could better present allergic sensitisation to workplace allergens and its implications to respiratory impairment in the exposed workers. Fungal types present in working area were not determined, and the SPT was done with a fungal mixed extract which is a common allergen. SIC with tea dust and its relationship to data obtained from serial PEFR measurements and bronchoprovocation testing would have made it possible to compare different methods in the detection of allergic OA.

In conclusion, we found higher prevalence of respiratory symptoms and spirometric changes

in a group of subjects occupationally exposed to herbal and fruit tea dust than in unexposed controls. Sensitisation to workplace and common inhalant allergens, BHR, and asthma was similar in both groups. A causal relationship between the workplace and asthma, suggesting allergic OA, was documented in one tea worker with asthma and was based on serial PEFR measurement and serial bronchoprovocation testing. A specific workplace agent causing asthma in the affected subject was not identified. None of the tea workers with asthma met the criteria for the medical case definition of RADS. Our study confirms the need for regular medical examinations in order to implement appropriate preventive measures to reduce the risk of herbal and fruit tea dust exposure.

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Sažetak

PROFESIONALNA ASTMA U RADNIKA IZLOŽENIH PRAŠINAMA IZ BILJNIH I VOĆNIH ČAJEVA

Svrha je ovoga presječnog ispitivanja bila otkriti profesionalnu astmu u skupini od 63 ispitanika koji su na radnome mjestu bili izloženi prašinama biljnih i voćnih čajeva. Kao kontrola uzet je jednak broj uredskih radnika koji nisu bili izloženi ovim prašinama. Ocjena izloženih i kontrolnih ispitanika obuhvatila je upitnik, *skin prick* testove na uobičajene i profesionalne inhalacijske alergene, spirometriju te histaminski test. Povezanost astme s profesionalnom izloženosti u radnika utvrđena je prema kriterijima Američkog kolegija pulmologa (American College of Chest Physicians, krat. ACCP), a na temelju mjerenja niza vršnih ekspiratornih protoka (engl. *peak expiratory flow rate*, PEFR) i niza bronhoprovokativnih testova. Izloženi su radnici iskazali veću prevalenciju respiratornih simptoma odnosno niže spirometrijske vrijednosti od kontrole. Izloženi ispitanici nisu se značajno razlikovali od kontrole u prevalenciji senzibilizacije na profesionalne i uobičajene inhalacijske alergene te prevalenciji pretjerane bronhalne reaktivnosti (engl. *bronchial hyperresponsiveness*, krat. BHR). Isto vrijedi i za prevalenciju astme (8,0 % u izloženih radnika prema 6,4 % u kontrola; P=0,540). Povezanost simptoma s poslom prijavili su svi radnici u obradi čaja oboljeli od astme te ni jedan kontrolni ispitanik s astmom. U jednoga astmatičnog radnika na čaju utvrđene su značajne promjene u dnevnim varijacijama PEFR-a te u nespecifičnom BHR-u koji upućuju na profesionalnu astmu (1.6 %). Nije utvrđeno koja je to tvar uzrokovala profesionalnu astmu u ovog ispitanika. Nitko od izloženih radnika s astmom nije zadovoljio sve medicinske kriterije za dijagnozu sindroma reaktivne disfunkcije dišnih putova (engl. *reactive airway dysfunction syndrome*, RADS). Naši podaci potvrđuju da je profesionalna izloženost prašinama iz biljnih i voćnih čajeva čimbenik rizika od profesionalne astme.

KLJUČNE RIJEČI *bronhoprovokativni testovi, profesionalna izloženost, vršni ekspiratorni protok, skin prick test*

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