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RESPIRATORY EFFECTS OF EXPOSURE TO DUST FROM HERBS

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Abstract: A group of 150 people occupationally exposed to dust from herbs were examined. As a reference group, 50 urban dwellers, not exposed to any kind of organic dust were examined. People were subjected to routine physical examination and to lung function examinations with the LUNGTEST 500 spirometer (MES, Kraków, Poland). The spirometric values of the forced expiratory volume in one second (FEV_1), vital capacity (VC) and FEV_1/VC were recorded before and after work. Physical chest examination revealed pathological crepitations in 10 people (6.7%). The mean baseline spirometric values in the study and reference groups did not show significant differences compared to the normal values. In the herb workers exposed to organic dust the post-shift decrease of all analysed spirometric values was noted. The post-shift decrease of some spirometric values (VC, VC% of normal values) was highly significant ($p<0.01$). There was evidenced of a significant positive correlation between the age of examined people and decrease of VC and FEV_1 values. In 12 exposed workers the decrease of FEV_1 or FEV_1% of normal values higher than 15% was noted. 50% of these workers cultivated thyme (*Thymus vulgaris* L.). This may suggest that dust from herbs, especially thyme dust, may cause acute airway obstruction. In the group showing significant decrease of FEV_1/FEV_1% of normal values (>15%) the frequency of reported respiratory work-related symptoms (83.3%) was higher than in the rest of exposed group (61.5%). In conclusion, occupational exposure to dust from herbs may cause harmful effects on the respiratory system among herb processing workers. This indicates the need for use of prophylactic measures in this professional group, the more so as number of people occupationally exposed to dust from herbs is growing.

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Key words: spirometry, occupational exposure, lung function, allergy, herbs, organic dust, thyme, camomile, sage.

INTRODUCTION

Occupational exposure to organic dust and endotoxin may cause various respiratory diseases, including asthma, allergic alveolitis, chronic bronchitis, toxic pneumonitis [9, 10, 17, 18, 20, 30], as well as acute and/or chronic lung function impairment [25, 33, 35, 36]. Several cross-sectional studies in different work environments were conducted to assess the relationship between occupational exposure to bioaerosols and over-shift changes in lung function. Zock *et al.* [35] examined a group of potato processing workers and observed across-shift decrease in FEV_1 and MEF values associated with the exposure to airborne endotoxin. Mandryk *et al.* [15, 16] found dose-response relationship between wood dust concentration and post-shift reduction of FEV_1, $FEV_{25-75\%}$ and FVC.

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Longitudinal studies conducted by Zuskin *et al.* [36] among textile workers and by Post *et al.* [25] among workers in grain processing and animal feed industry revealed that exposure to endotoxin may lead to increase in annual decline in lung function compared to unexposed population.

To the best of our knowledge, there is no study assessing lung function among workers exposed to herb dust. Herbs, according to the definition given by Robbers and Tyler [27], are nonwoody plants that die to the ground at the end of the growing season and are sources of crude drugs utilized for the treatment of disease states, often of a chronic nature, or to attain or maintain a condition of improved health.

The marked growth of the world herb production, processing and usage has been noted during the last 15 years - only in Europe the herbal medicinal products market reached the value of 7 billion USD in 1997, in Asia 4.4 billion USD, in USA (data for 1996) - 3.2 billion USD [5]. This gives a significant number of people occupationally exposed to herbs and dust from herbs. Nowadays, only in Poland there are about 100,000 farmers cultivating herbs. Another occupational group also exposed to herbal allergens are workers of herb processing plants (over 2,500 in Poland). So far, few cases of work-related respiratory diseases due to dust from herbs were reported [8, 11, 12, 14, 24]. Lemiere *et al.* [12] described the onset of occupational bronchial asthma caused by aromatic herbs. Mackiewicz *et al.* [14] reported a case of allergic alveolitis in 51-year-old female farmer due to occupational exposure to dust from thyme (*Thymus vulgaris* L.).

The aim of this study was to assess the effects of exposure to dust from herbs on the lung function of herb farmers and workers of herb processing industry.

MATERIALS AND METHODS

Examined population. The group of 150 workers occupationally exposed to dust from herbs (66 males and 84 females), aged 15–74 yrs (mean ± SD: 42.8 ± 11.8 yrs) were included in the study. The examined group consisted of 47 thyme farmers, 32 camomile farmers, 31 sage farmers and 40 workers of herbs processing industry. Additionally, 50 urban dwellers, not exposed to any kind of organic dust served as controls. The group consisted of 24 males and 26 females, aged 20–65 yrs (mean ± SD: 37.4 ± 12.1 yrs). The detailed characteristics of the examined groups is presented in Table 1 and Figure 1.

Figure 1. The average period of work (years, mean ± S.D.) in exposure to dust from herbs in the examined population.

All subjects gave formal consent to participate in the study. The Ethics Commission of the Institute of Agricultural Medicine approved human subjects protocols.

Physical examination. A routine physical examination consisted of auscultation of the chest with the use of a stethoscope was conducted.

Lung function changes. To study the changes, the exposure test in the group of 150 herb workers was performed. The pre-shift and post-shift lung function examinations were conducted in the workplaces of 150 herb workers. The examinations were performed with the use of LUNGTEST 500 spirometer, produced by MES (Kraków, Poland). Vital capacity (VC), forced expiratory volume in the first second (FEV_1) and FEV_1/VC (%) were measured. Results were expressed as absolute values and as percentages of predictive values. The lung function testing was performed in accordance with European Respiratory Society guidelines [26].

Table 1. General characteristics of the exposed and reference groups.

Groups	Average age ± S.D.	Gender		Smoking status		
		Males	Females	Smoking	Non-smoking	Ex-smoking
Thyme farmers (N=47)	41.26 ± 12.34	23 (48.9%)	24 (51.1%)	18 (38.3%)	25 (53.2%)	4 (8.5%)
Camomile farmers (N=31)	41.68 ± 15.39	20 (64.5%)	11 (35.5%)	9 (29.0%)	16 (51.6%)	6 (19.4%)
Sage farmers (N=32)	42.78 ± 12.06	17 (53.1%)	15 (46.9%)	7 (21.9%)	23 (71.9%)	2 (6.2%)
Herb farmers (N=110)	41.83 ± 13.09	60 (54.5%)	50 (45.5%)	34 (30.9%)	64 (58.2%)	12 (10.9%)
Workers of herb processing industry (N=40)	45.33 ± 6.22	4 (10.0%)	36 (90.0%)	18 (45.0%)	13 (32.5%)	9 (22.5%)
Exposed group (N=150)	42.77 ± 11.74	66 (44.0%)	84 (56.0%)	52 (34.7%)	77 (51.3%)	21 (14.0%)
Reference group (N=50)	37.36 ± 12.08	24 (48.0%)	26 (52.0%)	16 (32.0%)	28 (56.0%)	6 (12.0%)

Table 2. Spirometric values in the groups of herb workers.

Spirometric parameter	Thyme farmers N=47		Camomile farmers N=32		Sage farmers N=31		Workers of herb processing facility N=40		Total herb workers N=150	
	pre-shift	post-shift	pre-shift	post-shift	pre-shift	post-shift	pre-shift	post-shift	pre-shift	post-shift
VC (dm^3) x±S.D.	3.8±1.1	3.9±1.0	4.0±0.8	3.9±0.8	4.0±1.0	3.8±1.0	3.4±0.7	3.3±0.6*	3.8±0.9	3.7±0.9**
VC % of normal values x±S.D.	95.4±17.6	98.0±17.8	97.8±13.0	95.6±11.9*	95.2±16.4	94.6±13.9	103.2±15.8	100.4±13.9*	98.1±15.9	96.8±14.4**
FEV_1 (dm^3) x±S.D.	3.0±0.8	2.9±0.8	3.3±1.0	3.3±1.0	3.0±0.7	3.0±0.8	2.6±0.5	2.6±0.6	2.97±0.78	3.0±0.8
FEV_1 % of normal values x±S.D.	90.7±12.8	89.6±14.9	95.8±18.4	94.7±19.2	91.2±11.7	90.0±13.3	94.0±14.5	92.5±17.3	92.7±14.1	91.8±15.8
FEV_1/VC% x±S.D.	77.0±12.9	75.7±13.5	90.9±18.5	94.6±18.3	80.1±9.4	81.7±8.3	76.7±9.9	77.4±10.1	80.5±13.7	81.5±14.4

*-***: post-shift value significantly smaller compared to pre-shift; * $p < 0.05$, ** $p < 0.01$.

Table 3. Spirometric values in the exposed group considering gender and tobacco smoking.

Spirometric parameter	Females N=84		Males N=66		Smoking N=52		Non-smoking N=77		Ex-smoking N=21	
	pre-shift	post-shift	pre-shift	post-shift	pre-shift	post-shift	pre-shift	post-shift	pre-shift	post-shift
VC (dm^3) x±S.D.	3.3±0.7	3.2±0.7*	4.3±0.8	4.3±0.8	4.0±1.0	3.8±1.0*	3.6±0.8	3.5±0.8*	3.8±0.7	3.7±0.6
VC % of normal values x±S.D.	101.1±17.4	99.5±16.1*	94.0±12.8	93.2±10.9	98.7±14.8	95.7±13.3*	99.5±15.8	96.7±13.1*	99.8±13.7	95.9±9.4*
FEV_1 (dm^3) x±S.D.	2.5±0,5	2.6±0.6	3.5±0.7	3.4±0.8*	3.2±1.0	3.1±1.0	2.8±0.7	2.8±0.7	3.0±0.7	2.9±0.8
FEV_1 % of normal values x±S.D.	92.1±14.1	92.8±16.5	93.4±14.2	90.6±14.9*	94.4±17.6	92.5±18.3*	93.0±13.7	94.0±15.6	93.9±10.9	88.4±12.8
FEV_1/VC% x±S.D.	78.4±12.0	80.3±12.8	83.3±15.2	83.0±16.3	84.3 ±18.1	85.3 ±17.0	81.1±11.3	83.9±12.9	80.2±12.3	80.6±13.5

*-***: post-shift value significantly smaller compared to pre-shift; * $p < 0.05$.

Table 4. General characteristics of the exposed groups "A" and "B" with the decrease of post-shift FEV_1 (or FEV_1%) values higher than 15% and lower than 15%, respectively.

Group	Age x ± S.D.	Gender		Smoking status		
		Males	Females	Smoking	Non-smoking	Ex-smoking
"A" ↓FEV_1>15% N=12	44.0 ± 7.2	41.7%	58.3%	33.3%	16.7%	50.0%
"B" ↓FEV_1<15% N=138	42.6 ± 12.0	44.2%	55.8%	34.8%	54.3%	10.9%

Questionnaire examination. All people were interviewed by the American Thoracic Society Standard Questionnaire compiled by Ferris [2] and by the questionnaire developed in the Institute of Agricultural Medicine in Lublin for the examination of work-related symptoms caused by organic dusts [6].

Statistical analysis. Distribution of variables was checked for normality by Shapiro-Wilk test. Depending on the result, variables showing normal distribution were analysed by Student's t-test and Pearson's test for correlation, while others were analysed by Wilcoxon test, Mann-Whitney U test and Spearman test for correlation.

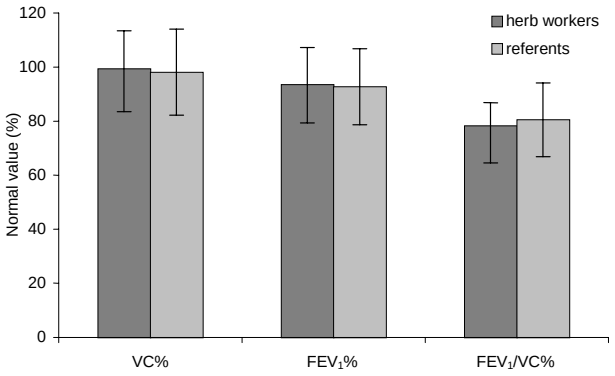


Figure 2. Mean spirometric values in the groups of herb workers and referents.

For the analysis of discrete variables the chi-square test was used. The $p<0.05$ level was considered significant.

The decrease of FEV_1 and FEV_1 % of normal values was defined according to formula: FEV_1 pre - FEV_1 post / FEV_1 max [31, 32].

The statistical analysis was carried out with the use of the Statistica™ ver. 4.5 package (Statsoft©, Inc., Tulsa, Oklahoma, USA).

RESULTS

Chest auscultation. On chest auscultation, pathologic symptoms were found in 10 herb workers (6.7%), including: 3 thyme farmers, 4 sage farmers and 3 workers of herb processing plant. These comprised dry rales in 5 cases, coarse rales in 3 cases, crepitation in 1 case and wheezing also in 1 case. No pathologic symptoms were found by chest auscultation in the reference group.

Lung function changes. The mean baseline spirometric values in the study and reference groups did not show significant differences compared to the normal values. No significant differences were found between the spirometric values in the group of herb workers and the reference group (Fig. 2).

The post-shift decrease of all analysed spirometric values, compared to the pre-shift values, was noted (Tab. 2). The post-shift decrease of vital capacity values (VC, VC% of normal values) was highly significant in the total exposed group ($p<0.01$). The post-shift decrease of VC and VC% of normal values was also significant in the subgroup of herb processing workers ($p<0.05$). In camomile farmers, VC% of normal values also decreased significantly after work ($p<0.05$).

The analysis of the pre- and post-shift lung function changes in the exposed group considering gender and tobacco smoking revealed significant decrease of FEV_1 and FEV_1 % of normal values in males from the exposed group and a significant decrease of FEV_1 % of normal values in the group of tobacco smokers ($p<0.05$), (Tab. 3). Post-shift values of VC and VC% of normal values significantly decreased in females, smokers and non-smokers and post-shift values of VC% of normal values decreased significantly also in ex-smokers (Tab. 3).

The spirometric values (VC post-shift, FEV_1 pre- and post-shift) decreased together with the age of herb workers and the correlation proved to be significant ($p<0.05$) (Fig. 3-4). No correlation between the number of years of occupational exposure to dust from herbs and spirometric data was observed.

Closer analysis of FEV_1 and FEV_1 % of normal values was conducted by the separation of a subgroup of 12 workers who showed a decrease of FEV_1 or FEV_1 % of normal values higher than 15%. This subgroup, denoted as group "A", was compared with the remaining subgroup of 138 herb workers, denoted as group "B", who did not show the decrease of FEV_1 or FEV_1 % of normal values higher than 15%. In 10 persons of group "A" the decrease of both above-mentioned values was observed, in 1 person - of FEV_1 and in 1 person - of FEV_1 % of normal values. Within this group, 6 persons were thyme farmers, 5 - herb processing industry workers and 1 - sage farmer. No significant differences between groups "A" and "B" were noted considering age (Tab. 4) and duration of work (group "A": 15.5±10.8 years of work, group "B": 17.5±11.4 years of work).

In group "A" the frequency of reported respiratory work-related symptoms (83.3%) was higher than in group

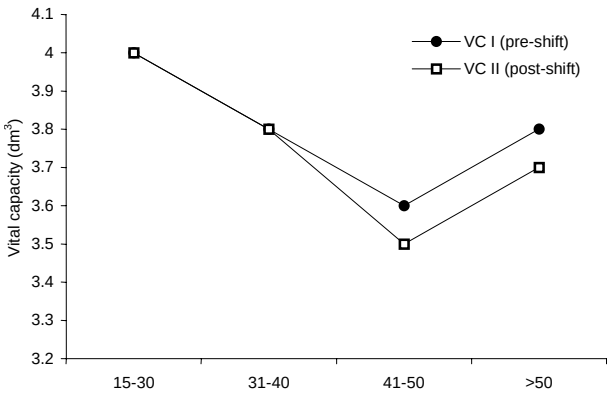


Figure 3. Correlation between the age of herb workers and vital capacity (VC) values, significant for post-shift values ($p<0.05$, Spearman's correlation coefficient r = - 0.21).

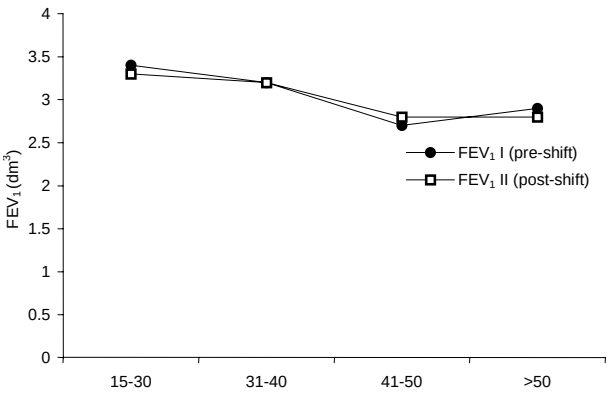
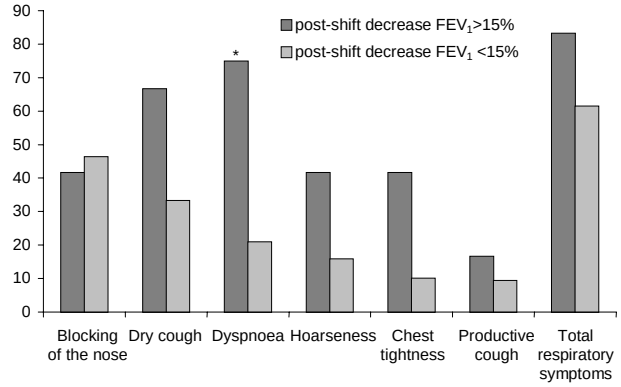
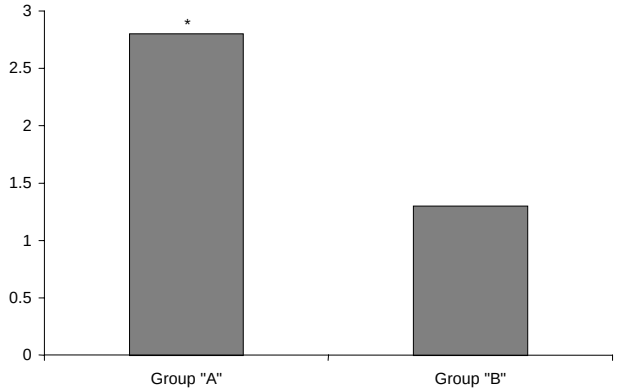


Figure 4. Significant correlation between age of herb workers and forced expiratory volume in the first second values (FEV_1), for pre-shift ($p<0.01$, Spearman's correlation coefficient r = - 0.29) and post-shift ($p<0.01$, Spearman's correlation coefficient r = - 0.25).



*-***: significant difference between groups “A” and “B”; * p < 0.05.

Figure 5. Prevalence of respiratory work–related symptoms in the groups “A” (N=12) and “B” (N=138) with the decrease of post-shift FEV_1 (or FEV_1 %) values higher than 15% and lower than 15%, respectively.



*-***: significant difference between groups “A” and “B”; * p < 0.05.

Figure 6. Mean number of reported work-related symptoms per person in the groups “A” (N=12) and “B” (N=138) with the decrease of post-shift FEV_1 (or FEV_1 %) values higher than 15% and lower than 15%, respectively.

“B” (61.5%) (Fig. 5). The difference was especially high in the case of dyspnoea and its frequency in group “A” was significantly greater ($p<0.05$) compared to group “B”. The mean number of reported work-related respiratory symptoms was significantly greater ($p<0.05$) in group “A” (average number: 2.8 per person), compared to group “B” (average number: 1.3 per person) (Fig. 6).

DISCUSSION

In the present study, exposure to dust from herbs caused post-shift decrease of all analysed spirometric values (VC, VC% of normal values, FEV_1, FEV_1 % of normal values, VC/FEV_1 %). The post-shift decrease of vital capacity (VC and VC% of normal values) in the exposed group was highly significant ($p<0.01$). Our findings are in line with the results regarding effects of organic dusts obtained by Milanowski *et al.* [21, 22] in furniture factory workers and potato processing workers, by Awad el Karim *et al.* [3] in workers exposed to grain and flour dusts, and by Skórska *et al.* [34] in farmers exposed to grain dust.

The greatest decline of post-shift vital capacity was observed in the subgroups of the workers of herb processing plants and camomile farmers. It is noteworthy that occupational asthma due to exposure to camomile was already described by several authors [4, 28].

The across-shift decrease in FEV_1 of over 15% was observed in 12 subjects out of 150 exposed workers (8.0%). There were no significant differences in age, gender, duration of exposure and tobacco smoking between this group of 12 persons and the rest of the examined group. As many as 50% of workers with over 15% post-shift decrease in FEV_1 cultivated thyme (*Thymus vulgaris* L.). This may suggest that dust from herbs, especially thyme dust, may cause acute airway obstruction. Abramson *et al.* in a study of herbal tea packers exposed to dust from herbs also underlined the presence of a group of workers with significant across-shift decrease in FEV_1 [1]. Acute reductions in FEV_1 were also observed by Zuskin and Skuric [37] in workers exposed to dust from herbs. Thyme has already been described as a causative agent of airways impairment - Lemiere *et al.* described occupational asthma due to exposure to thyme [12].

In the group with across-shift decrease in FEV_1 of over 15% the frequency of reported respiratory work-related symptoms (83.3%) was higher than in the rest of exposed group (61.5%). In the case of some symptoms, such as dyspnoea, this difference was significant ($p<0.05$). The mean number of work-related respiratory symptoms was significantly higher in the group with a significant decline of FEV_1, compared to the rest of exposed group ($p<0.05$). Similar results were obtained by Abramson *et al.* in herbal tea packers, although in that study the statistical significance of this relationship was not observed due to low number of examined subjects [1].

The noted harmful effects of the exposure to dust from herbs on the respiratory system of the exposed people indicates the need for use of prophylactic measures including: individual masks or respiratory helmets [7, 23] and efficient ventilation of the work places [29].

CONCLUSION

Occupational exposure to dust from herbs may cause harmful effects on the respiratory system of herb processing workers, evidenced by a significant post-shift decrease of spirometric values.

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