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HEALTH EFFECTS OF EXPOSURE TO ORGANIC DUST IN WORKERS OF A MODERN HATCHERY

Czesława Skórska[1], Barbara Mackiewicz[2], Marcin Golec[1], Grażyna Cholewa[1], Anna Chmielowiec-Korzeniowska[3], Jacek Dutkiewicz[1]

[1]Department of Occupational Biohazards, Institute of Agricultural Medicine, Lublin, Poland
[2]Department of Pneumonology, Oncology and Allergology, Medical University of Lublin, Poland
[3]Department of Animal Hygiene and Environment, Faculty of Biology and Animal Breeding, Agricultural University of Lublin, Poland

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Abstract: The aim of the presented study was to determine the health status of workers occupationally exposed to moderate amounts of organic dust, employed in a modern hatchery with an efficient ventilation system. A group of 32 hatchery workers was examined. As a reference group, 50 urban dwellers not exposed to any kind of organic dust were examined. All people were interviewed for the presence of work-related symptoms and subjected to physical and spirometric examinations. Blood sera were examined for the presence of precipitins against 13 antigens associated with organic dust, and for the presence of total and chicken-specific No significant differences were found between the spirometric values in the group of hatchery workers and the reference group. Positive precipitin reactions were noted mostly with the antigens of Gram-negative bacteria associated with organic dust. The frequencies of positive reactions to antigens of *Escherichia coli* and *Acinetobacter baumannii* in hatchery workers were significantly greater compared to the reference group ($p<0.05$). Precipitin reactions to Gram-positive non-branching bacteria, actinomycetes, fungi and bird protein, were rare or absent. The mean concentration of total IgE in sera of hatchery workers was nearly 3 times greater compared to the reference group, and the difference proved to be statistically significant ($p<0.05$). No specific IgE antibodies against chicken feathers were detected in the blood of hatchery workers and referents. In conclusion, the examined hatchery workers showed a moderate frequency of work-related symptoms, no decline in lung function and low reactivity to most microbial and bird protein allergens. These results suggest that the effects of exposure to organic dust in workers of modern hatcheries with an efficient ventilation system are less compared to the workers of poultry farms, such as broiler or egg laying houses.

Address for correspondence: Dr Czesława Skórska, Department of Occupational Biohazards, Institute of Agricultural Medicine, Jaczewskiego 2, 20-090 Lublin, Poland.
E-mail: skorska@galen.imw.lublin.pl

Key words: hatchery workers, occupational exposure, organic dust, work-related symptoms, spirometry, allergy, precipitins, IgE.

INTRODUCTION

It has been demonstrated that the air on poultry farms is polluted with large quantities of organic dust, microorganisms, endotoxin, glucan and noxious gases which cause adverse health effects in exposed workers [3, 18, 19, 21, 22, 23, 25]. These effects include work-related respiratory symptoms, chronic pulmonary disease, decline in lung function, increased airway responsiveness and allergic reactions [9, 14, 19, 20, 21, 24, 30, 32]. So far, relatively little

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is known about the risk associated with exposure to adverse air pollutants in hatcheries. In the studies performed 20-35 years ago by a group from the Institute of Agricultural Medicine in Lublin [4, 5, 6, 26] large concentrations of dust and airborne bacteria were found in the hatcheries of chicks and ducklings. Nearly half (45.4%) of the workers employed in hatcheries over 3 years reported occurrence of respiratory, conjunctival and skin symptoms associated with the performed work, mainly at the time of removing chickens from hatching boxes [4]. In the study performed recently in an industrial, modern hatchery with an efficient ventilation system, a much lower degree of exposure to dust and bio-pollutants was found [2].

The aim of the present study conducted in the same modern hatchery was to investigate whether lower exposure to air pollutants results in an improved health status of the workers compared to that recorded in the hatcheries of older type with less efficient ventilation [4].

MATERIALS AND METHODS

Examined population. A group of 32 hatchery workers occupationally exposed to organic dust were examined. The group comprised 18 males and 14 females, aged 38.0 ± 10.8 yrs (range 21-58 yrs). The mean duration of employment was 4.3 ± 5.4 yrs (range 0.25-30 yrs). In the examined group, 56.3% (18 persons) were tobacco smokers, 3.1% (1 person) ex-smokers and 40.6% (13 persons) were non-smokers.

All the examined hatchery workers were employed at a big, modern poultry hatchery with an efficient ventilation system, located in Dębówka (20 km south of Warsaw, Poland). The hatchery has an annual output of 20-25 million Cobb and Ross meat hens. In the earlier conducted studies on air pollution inside this facility [2, 31] we found a moderate degree of exposure to dust, bacteria, endotoxin and odorogenous gases.

As a reference group, 50 urban dwellers living in city of Lublin and not exposed to any kind of organic dust were examined. The group consisted of 24 males and 26 females, aged 37.4 ± 12.1 yrs (range 20-65 yrs). In the reference group, 32.0% (16 persons) were tobacco smokers, 12.0% (6 persons) ex-smokers and 56.0% (28 persons) were non-smokers.

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

Questionnaire examination. All people were interviewed by the American Thoracic Society Standard Questionnaire (ATS Questionnaire) compiled by Ferris [1], and by the questionnaire developed in the Institute of Agricultural Medicine in Lublin for the examination of work-related symptoms caused by organic dusts [7].

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

Lung function changes. The examinations were performed in the groups of hatchery workers and referents 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. The lung function testing was performed in accordance with European Respiratory Society guidelines [17].

Agar-gel precipitation test. Blood sera of hatchery workers and referents were tested with 13 antigens, comprising 12 antigens of microorganisms associated with organic dust and chicken protein as a bird antigen. Antigens of the following microorganisms, occurring commonly in the agricultural working environment of eastern Poland and reported as causative agents of work-related respiratory disorders, were used for the production of antigens:

- Gram-negative bacteria of the species *Acinetobacter baumannii*, *Acinetobacter calcoaceticus*, *Alcaligenes faecalis*, *Escherichia coli* and *Pantoea agglomerans* (syn.: *Erwinia herbicola*, *Enterobacter agglomerans*);
- Gram-positive non-branching bacteria of the species *Arthrobacter globiformis* and *Bacillus subtilis*;
- Actinomycetes of the species *Streptomyces albus*, *Saccharopolyspora rectivirgula* (syn.: *Micropolyspora faeni*, *Faenia rectivirgula*) and *Thermoactinomyces vulgaris*;
- Fungi of the species *Aspergillus fumigatus* and *Penicillium citrinum*.

Lyophilised saline extracts of bacterial or fungal mass produced at the Institute of Agricultural Medicine in Lublin, were used as antigens. In the case of mesophilic, non-branching bacteria the mass was harvested from nutrient agar cultures, while in the case of actinomycetes and fungi the mass was harvested from sugar broth cultures. Then, the mass was homogenised and extracted in saline (0.85% NaCl) in the proportion 1:2 for 48 hrs at 4°C, with intermittent disruption of cells by 10-fold freezing and thawing. Afterwards, the supernatant was separated by centrifugation, dialysed against distilled water for 24 hrs, concentrated by evaporation to 0.1-0.15 of previous volume and lyophilised [15, 27, 28, 29].

The agar-gel precipitation test was performed by the Ouchterlony double diffusion method in purified 1.5% *Difco* agar. The examined serum was placed in the central well and antigens in the peripheral wells. The antigens were dissolved in saline at the concentration of 30 mg/ml. The plates were incubated for 6 days at room temperature, then washed in saline and 5% sodium citrate solution (to prevent false positive reactions), and stained with azocarmine B [16, 27, 28, 29].

Determination of IgE. Concentration of the total and chicken feather – specific IgE antibodies in blood sera was performed with the ELISA method using commercial reagent kits (Siemens Medical Solutions Diagnostics, Los Angeles, CA, USA) and automatic chemiluminescent

analyser Immulite 2000 (DPC Biermann GmbH, Bad Neuheim, Germany).

Statistical analysis. Statistical analysis was performed with the use of Student's t-test and Pearson's test for correlation. The $p<0.05$ level was considered significant. The statistical analysis was carried out with the use of the Statistica™ ver. 5.0 package (Statsoft©, Inc., Tulsa, Oklahoma, USA).

RESULTS

Occurrence of work-related symptoms. 8 hatchery workers (25%) reported occurrence of work-related symptoms associated with exposure to dust (Tab. 1). The most common complaints were dry cough and blocking of the nose reported each by 3 workers (9.4%). Hoarseness was reported by 2 workers (6.3%). Productive cough, dyspnoea, chest tightness and conjunctivitis were reported each by 1 worker (3.1%). Among 8 workers having work-related symptoms, 4 persons reported only 1 symptom, 1-2 symptoms, and 2-3 symptoms.

None of the members of the reference group reported the occurrence of work-related symptoms.

Respiratory disease. 2 hatchery workers (6.3%) and 3 referents (6.0%) reported symptoms characteristic for chronic bronchitis according to the ATS questionnaire. 11 hatchery workers (34.4%) and 6 members of reference group (12.0%) reported past history of respiratory disease. The difference between groups was statistically significant ($p<0.05$). Among hatchery workers, bronchitis and pneumonia were reported by 5 persons each (15.6%), while bronchial asthma and pollinosis by 3 persons each (9.4%). 6 persons reported past history of 1 disease and 5 – of 2 diseases. In the reference group, bronchitis was reported by 5 persons (10.0%) and pneumonia by 1 person (2.0%). All persons reported past history of 1 disease.

Table 1. Prevalence of work-related symptoms in hatchery workers occupationally exposed to organic dust (N=32).

Work-related symptoms	Workers reporting symptoms (number, percent)
Dry cough	3 (9.4%)
Productive cough	1 (3.1%)
Dyspnoea	1 (3.1%)
Chest tightness	1 (3.1%)
Blocking of the nose	3 (9.4%)
Hoarsness	2 (6.3%)
Fever	0
Shivering	0
Nausea	0
Vomiting	0
Headache	0
Malaise	0
Increased perspiration	0
Joint and muscle aching	0
Body pain	0
Fatigue	0
Body itching	0
Rash	0
Conjunctivitis	1 (3.1%)
Total number of workers reporting work-related symptoms	8 (25.0%)

Table 2. Mean spirometric values in hatchery workers and referents ($\bar{x} \pm$ S.D.).

	Hatchery workers (N=32)	Reference group (N=50)
FEV_1 (litres)	3.44 ± 0.68	3.24 ± 0.88
FEV_1 (% predicted)	102.6 ± 10.0**	93.7 ± 13.9
VC (litres)	4.20 ± 0.86	4.04 ± 1.02
VC (% predicted)	103.1 ± 13.4	99.2 ± 14.3
FEV_1/VC (%)	80.7 ± 6.6	78.5 ± 8.4

**significantly greater compared to reference group ($p<0.01$).

Chest auscultation. No pathologic symptoms were found by chest auscultation in hatchery workers and referents.

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 hatchery workers and the reference group (Tab. 2), except for FEV_1% index which was significantly greater in hatchery workers compared to the reference group ($p<0.01$). The spirometric values (VC, FEV_1) decreased together with the age of hatchery workers and referents but the correlation proved to be significant only in referents ($p<0.001$, Pearson's correlation coefficient $r = -0.534$ for FEV_1 values and $r = -0.476$ for VC values). No significant relationship could be found between the duration of employment and spirometric values.

Agar gel precipitation test. Positive precipitin reactions were noted mostly with the antigens of Gram-negative bacteria associated with organic dust (Tab. 3). The frequencies of positive reactions to antigens of *Escherichia coli* and *Acinetobacter baumannii* in hatchery workers were significantly greater compared to the reference group ($p<0.05$). Precipitin reactions to Gram-positive non-branching bacteria, actinomycetes, fungi and bird protein were rare or absent. No significant relationship could be found between the presence of precipitins in hatchery workers and the occurrence of work-related symptoms or past respiratory diseases.

IgE antibodies. The mean concentration of total IgE in sera of hatchery workers was nearly 3 times greater com-

Table 3. Frequency of positive precipitin reactions to antigens associated with organic dust in hatchery workers and referents.

Antigen	Persons showing positive reactions (number, %)	
	Hatchery workers (N=32)	Reference group (N=50)
Gram-negative bacteria		
Acinetobacter baumannii	3 (9.4%)*	0
Acinetobacter calcoaceticus	1 (3.1%)	2 (4.0%)
Alcaligenes faecalis	1 (3.1%)	4 (8.0%)
Escherichia coli	11 (34.4%)*	6 (12.0%)
Pantoea agglomerans	7 (21.9%)	6 (12.0%)
Gram-positive non-branching bacteria		
Arthrobacter globiformis	0	0
Bacillus subtilis	1 (3.1%)	0
Actinomycetes		
Saccharopolyspora rectivirgula	0	0
Streptomyces albus	1 (3.1%)	0
Thermoactinomyces vulgaris	0	0
Fungi		
Aspergillus fumigatus	0	4 (8.0%)
Penicillium citrinum	0	0
Bird proteins		
Chicken serum	1 (3.1%)	0

*significantly greater compared to reference group ($p<0.05$).

Table 4. Levels of antibodies of IgE class (international units/ml, IU/ml) in sera of hatchery workers and referents ($\bar{x} \pm$ S.D.).

	Hatchery workers (N=32)	Reference group (N=50)
Total IgE	145.1 ± 221.5*	49.1 ± 68.1
Specific IgE to chicken feather	All < 0.1	All < 0.1

*significantly greater compared to reference group ($p<0.05$).

pared to the reference group, and the difference proved to be statistically significant ($p<0.05$) (Tab. 4). No significant relationship could be found between the level of total IgE in hatchery workers and the occurrence of work-related symptoms or past respiratory diseases. No specific IgE antibodies against chicken feather were detected in the blood of hatchery workers and referents (Tab. 4).

DISCUSSION

The results of the present work suggest that the workers of the modern hatchery with a relatively low exposure to air pollutants noted in an earlier study [2, 31] reveal an improved health status compared to that recorded in the past in the hatcheries of older type with less efficient ventilation [4]. The frequency of work-related symptoms in the examined hatchery workers (25%) was also substantially lower compared to the values found in the earlier studies of our group in people occupationally exposed to other organic dusts: herb growing farmers (30.7-80.6%) [10, 11, 12, 29], workers of herb processing facility (76.5%) [8], flax growing farmers (62.7%) [28], grain farmers (44.7%) [27], and pig farmers (58.5%) [13]. The small percentage of hatchery workers reporting work-related symptoms may also be attributed to the short duration of employment of most persons.

The performed lung function tests did not reveal any significant differences in spirometric values between the hatchery workers and the members of reference group not exposed to organic dust. Hatchery workers did not show any pathological changes in physical examination, and the prevalence of chronic bronchitis was similar to the reference group.

By contrast, the studies of poultry farmers more exposed to bioaerosols (those breeding broilers and egg laying hens) revealed a significant decline in lung function [3, 21, 32], high prevalence of chronic pulmonary disease [9, 14, 21, 24, 30], and common occurrence of work-related respiratory symptoms [20, 24, 32].

Hatchery workers showed significantly more precipitin reactions to antigens of *Escherichia coli* and *Acinetobacter baumannii* than the members of the reference group. These Gram-negative bacteria were commonly recovered from the air of hatchery where workers were employed. However, the precipitin reactions showed no correlation with the occurrence of work-related symptoms and thus should be regarded only as markers of exposure.

The concentration of total IgE in sera of hatchery workers was significantly greater compared to the reference group, but the reason for this is unclear. As hatchery workers did not have specific IgE antibodies against chicken proteins, the increased IgE level may be due to the presence of specific IgE antibodies to bacteria present in the air of the hatchery. However, such antibodies were not determined in the present work and hence this hypothesis needs to be verified by future studies.

In conclusion, the obtained results suggest that the effects of exposure to organic dust in workers of modern hatcheries with an efficient ventilation system are less compared to the workers of poultry farms, such as broiler or egg laying houses.

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INTERNATIONAL MEETINGS

20-23 February 2008, Cultural Centre Calabar, Cross River State, Nigeria. *VIII Wonca World Rural Health Conference.* **Contact:** www.ruralwonca2008.net

6-8 March 2008, San Antonio, Texas. *Focus on Fungal Infections 18.* **Contact:** www.imedex.com/announcements/304.asp#topics.

12-15 March 2008, Hamburg, Germany. *48th Annual Scientific Conference combined with ICOH Mid-term Meeting 2008.* **Topics:** • Ethical questions of occupational medicine; • Work related skin diseases; • Maritime medicine - a complex challenge for occupational medicine. **Contact:** www.dgaum.de

10-12 April 2008, Glasgow, United Kingdom. *8th International Conference – Healthy Working Lives for all: Crossing the OH multidisciplinary interface.* **Topics:** • Curriculum Development; • Training for specialists and non-specialists; • Integration of multidisciplinary training and education; • Harmonisation or coordination of multinational training; • Training Methods; • Examples of training modules: case management, rehabilitation, occupational epidemiology, work-related diseases; • Use of technology for teaching; • Utility of different teaching methods for uni-disciplinary, multi-disciplinary and multinational; • Methods of Assessment; • Workplace-based assessments; • Competency-based assessments; • Assessment in multi-disciplinary training; • Assessment to promote multinational recognition of competencies; • Continuing Professional Develo. **Contact:** http://www.hwlresearchgroup.org

21-23 April 2008, Toronto, Ontario, Canada. *Health & Safety Canada 2008 IAPA Conference & Trade Show.* **Topics:** • Healthy Workplaces; • Health and Safety Core Practices; • Leadership and Management Breakthroughs; • Evolving Innovations Through Research. Coverage includes new and emerging workplace issues in the areas of occupational disease, environment hazards, new technologies, nanotechnology, strategies for small and medium-sized enterprises and more. **Contact:** http://www.iapa.ca/conference

8-10 May 2008, Geraz do Minho (8th) and Braga (9th and 10th), Portugal. *I International School Congress – Environment, Health and Education.* **Contact:** http://www.cie-portugal.net

29-31 May 2008, Cracow, Poland. *5th International Conference on Work Environment and Cardiovascular Disease.* **Contact:** International Commission of Occupational Health (ICOH) & Nofer Institute of Occupational Medicine (NIOM); alab@sunlib.p.lodz.pl

9-13 June 2008, San Jose, Costa Rica. *EPICOH-NEUREOH 2008 (The 20th International Conference on Epidemiology in Occupational Health and the 10th International Symposium on Neurobehavioral Methods and Effects in Occupational and Environmental Health)*. **Contact:** http://www.epicoh-neureoh2008.com

19-21 June 2008, Łódź, Poland. *IX Central and Easter European Conference "Allergy, Asthma and Clinical Immunology".* **Topics:** The aim of the Conference is to provide up-to date information on diagnosis and management of allergic diseases. **Contact:** www.mediton.pl

29 June–2 July 2008, Seoul, Republic of Korea. *XVIII World Congress on Safety and Health at Work.* **Topics:** The congress aimed at contributing to the prevention of occupational accidents and the protection of workers' health through the exchange of information, knowledge and experiences on new technologies related to safety at work, on preventing occupational diseases, and on safety and health cooperative projects. **Contact:** http://www.safety2008korea.org/eng/

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17-22 August 2008, Copenhagen, Denmark. *Indoor Air 2008 – The 11th International Conference on Indoor Air Quality and Climate*. **Topics:** • Indoor Environmental Exposure assessment in buildings and vehicles; • Hazard Identification and dose-response assessment; • Risk Characterization in the indoor environment; • Control and Regulatory options; • Socio-economic context of management of the indoor environment. **Contact:** http://www.indoorair2008.org

21-22 August 2008, Basel, Switzerland. *II International Sustainability Conference "Creating Values for Sustainable Development".* **Topics:** The ISC 2008 provides a platform for both interdisciplinary and transdisciplinary oriented social scientists working in the field of sustainable development. The conference is committed to promoting dialogue, especially among economists and other social scientists. **Contact:** http://www.isc2008.ch

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1-3 October 2008, Chania, Crete, Greece. *I International Conference in Hazardous Waste Management "Hazardous Waste Management".* **Topics:** The Conference will focus on innovative aspects of Hazardous Waste (including organics, non-halogenated and halogenated solvents, hydrocarbons, pesticides, explosives, PCBs, PCDDs/Fs, heavy metals, asbestos, nuclear wastes, salts, etc.). Management, presenting new technologies, describing the state of the art and related case studies, discussing the main controversial subjects, sharing experience among different countries, valuating social and financial balances. **Contact:** http://www.hwm1.tuc.gr/

22-27 March 2009, Cap Town, South Africa. *29th International Congress on Occupational Health.* **Contact:** www.icoh2009.co.za

29 August–3 September 2010, Helsinki, Finland. *International Aerosol Conference 2010.*