RESPIRATORY HEALTH AND IMMUNOLOGICAL PROFILE OF POULTRY WORKERS

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Objectives. To examine work-related respiratory symptoms in poultry workers, and to test for immunologically mediated responses to poultry-related agents.

Design. A cross-sectional survey of differentially exposed poultry workers and unexposed blue-collar workers.

Setting. Three poultry farms and a poultry plant in Gauteng (exposed workers) and a municipal workers' clinic in Johannesburg (controls).

Participants. 134 poultry workers (85.4% of all eligible workers) and 122 controls (> 95% response rate).

Outcome measures. Respiratory symptoms plus allergy and hypersensitivity to poultry agents identified by skin-prick tests, and by the presence of specific IgE and IgG enzyme-linked immunoflow assay and nonspecific (radial immunodiffusion) antibodies.

Results. Smoking habits and atopic status were similar in the poultry workers and the controls. Symptoms were very common in poultry workers, for example work-related cough in 32% and work-related wheeze in 23% of highly exposed workers. Significantly more poultry workers than controls complained of chest symptoms (increasing with increasing exposure), and of eye, skin and nose irritation at work. More poultry workers than controls had symptoms consistent with asthma (e.g. 3%, 4%, 13% and 11% in controls and subjects with low, medium and high exposure, respectively), and symptom complexes associated with organic dust exposure. Five poultry workers had positive skin-prick test reactions to poultry-specific antigens, but none of the unexposed controls reacted. More poultry workers than controls had positive immunodiffusion test reactions to chicken feed, feathers and serum, and IgE to chicken faeces. There was no association between immunological status and respiratory symptoms.

Conclusion. We found a very high prevalence of exposure-related symptoms in poultry workers; improved hazard control is strongly indicated. Tests of allergy and hypersensitivity were associated with exposure, but not with disease. The possibility of useful tests of sensitisation has not been excluded; a prospective study design is likely to be more rewarding than cross-sectional approaches such as in this study.

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The poultry industry in South Africa is largely confined to chicken farming and processing, turkey and duck production being of minor importance. Nevertheless, the industry is significant with 4 large, 6 medium and about 300 small to very small commercial producers. In 1997, approximately 50 000 people worked directly or indirectly in poultry production, processing and meat handling.

Airborne contaminants to which poultry workers are exposed include organic poultry dust (skin debris, broken feathers, insect parts, aerosolised feed and faeces), ammonia[1] and a variety of immunogenic agents such as viable bacteria and bacterial endotoxins.[2,3]

Pulmonary diseases which may be induced by this type of exposure have been classified by Rylander[4] into toxic pneumonitis, mucous membrane irritation, bronchitis, granulomatous pneumonitis, rhinitis and asthma. Clinical presentation may be complex as the disease entities are not mutually exclusive, severity will vary with exposure intensity and symptoms may be influenced by the extent of tobacco use. It is therefore not surprising that investigations of poultry workers have shown high, but inconsistent, rates of respiratory symptoms.[5-7]

At least some of the symptomatology may be unrelated to poultry itself, as shown in an investigation of workers milling poultry food.[8] The evidence for respiratory dysfunction in these workers is not limited to subjective symptom reporting: impaired pulmonary function has been shown in workers regularly exposed to poultry,[9,10] and a reduction in lung function in poultry workers across the work shift has been demonstrated.[1,3,6,7,10]

These studies provide good evidence of increased respiratory disease in poultry workers, but specific conditions, such as occupational asthma or hypersensitivity pneumonitis (extrinsic allergic alveolitis), have been shown less clearly.

Given the complexity of the exposures, a number of agents could explain the high symptom prevalences. High levels of dust or ammonia may produce nonspecific inflammation,[4,10] and responses to endotoxins are likely,[2,3] as are specific immunological responses to feed or chicken antigens.

The facts that the scientific literature demonstrates a not

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insignificant health risk in chicken workers, and that no investigation of these workers had been done in South Africa, and the interesting issues related to mechanism of disease, all prompted the cross-sectional survey of chicken workers reported here.

Objectives were to describe the respiratory health and to construct an immunological profile of poultry workers in relation to their work environment, and specifically to investigate the relationship between symptoms and sensitisation to poultry-related antigens, and to detect workers with poultry-related asthma.

SUBJECTS AND METHODS

Subjects

Study subjects were the employees of a chicken processing company which operated poultry farms and poultry plants in a number of provinces of South Africa. The three farms and the poultry plant closest to the National Centre for Occupational Health, Johannesburg, were selected for study, and all production workers, catchers and hangers were invited to participate. Production workers rear the chickens in poultry confinement houses; tasks include the preparation of houses for new batches of chicks and routine activities like feeding and cleaning. Catching is done by hand; each catcher grabs a number of birds and loads them into crates for transport to the plant, where hangers receive the birds and shackle them to an overhead conveyor. The process was much as that described by Morris and colleagues.[7] Table I shows the study subjects by exposure category and task (job title).

Table I. Exposure category and level and job title of the poultry workers studied

Exposure category	Exposure level	Job title	*N*
Low	1	General worker	10
(*N* = 26)		Cook	5
		Driver	5
		Serviceman	2
		Painter	1
		Labourer	1
		Welder	2
Medium	4	Trainee houseman	4
(*N* = 55)		Manager	3
	5	Houseman	29
		Supervisor	8
		Poultry man	7
		Stockman	3
		Maintenance	1
High	10	Cleaner	17
(*N* = 53)		Hanger	16
		Catcher	15
		Bobcat driver	4
		Supervisor*	1

*Supervisor of catchers.

A reference group of blue-collar workers, not occupationally exposed to poultry-related agents or to animals, was selected from Johannesburg City Council workers attending the local authority workers' clinic. Workers referred to the clinic for routine periodic medical examinations on Tuesday, Wednesday and Thursday of 3 consecutive weeks were asked to participate. The response rate was over 95%, presumably because the study intervention was tagged onto routine procedures, for instance blood collection. One hundred and twenty-two controls were selected, of whom 58 (48%) were cleaners, 47 (39%) artisans or their assistants, and the remainder security guards, refuse collectors, messengers, etc.

Exposure assessment

Although part of the original study protocol, objective measurements of exposure to dust and other agents were not done because ownership of the company changed during the study and access was no longer available. Poultry workers were therefore categorised into low-, medium- or high-exposure classes on the basis of careful observation of work procedures and discussion with line managers. The literature was consulted to confirm that the categorisation was consistent with exposure intensities described in other studies. Table I shows tasks by exposure class.

Measurements

After discussion with the majority trade unions and obtaining informed consent from each subject, questionnaires were administered by trained interviewers, in the preferred language of the subject. The questionnaire covered exposure and occupational histories, medical history, respiratory health, and smoking habits. Respiratory symptom questions were derived from the ATS-DLD-78 questionnaire,[11] except that work-relatedness and asthma-like symptoms of waking at night with shortness of breath and morning chest tightness were added. Symptoms suggestive of hypersensitivity pneumonitis, namely fever, sore joints or muscles, headaches, malaise and cough, were also sought.

Allergies to agents in the poultry industry and hypersensitivity were investigated, using:

1. Skin-prick tests for common allergens (commercial preparations of tree mix pollen, five-grass pollen mix, feathers, Zea mays, house-dust mite, dog hair and epithelium, cat hair and epithelium, and Bermuda grass pollen; available from Bayer-Miles (Pty) Ltd.).

2. Skin-prick tests for poultry-specific allergens ('in-house' preparations of chicken serum, feathers, faeces, and chicken feed) using previously described methodology.[12] The agents were defatted in ether, air-dried, ground and then suspended in Coca's fluid and extracted by shaking for 72 hours. Extracts were filtered and then sterilised by millepore filtration (0.22 µm). Sterility tests were done by incubating on thiogycerate broth and brain-heart infusion media for 48 hours

at 20°C. The extracts were used in the enzyme-linked immunoflow assay (ELIFA) and radial immunodiffusion tests described below.

3. ELIFA was used to determine IgE and IgG antibodies to chicken serum, chicken feathers, chicken feed and chicken faeces. A 1:50 dilution of the various chicken antigens was attached to a nitrocellulose membrane. Casein in phosphate-buffered saline (PBS) was used to block sites on the membrane that had no antigens attached. A 1:5 dilution of unknown serum was added and pulled through the membrane. The membrane was washed three times with PBS-tween to clean excess conjugate solution. A peroxidase conjugate was drawn past the membrane-bound enzyme and the soluble coloured solution was transferred directly into a standard 96-well plate and read with an automated enzyme-linked immunosorbent assay (ELISA) plate reader at an absorbence of 492 nm.

4. Radial immunodiffusion tests were used to examine sera for precipitating antibody to chicken serum, feathers, feed or serum by diffusion in agar gel. This examination was done using the Ouchterlony immunodiffusion technique (The Binding Site, Birmingham Research Park, Birmingham, UK), according to the manufacturer's instructions.

Skin-prick testing was done by placing a small drop of each testing solution on the flexor side of the forearm and lightly piercing the epidermis through the drop with a lancet. The response was read after at least 10 minutes and graded relative to a positive histamine control, graded 4+, and a negative glycero-saline control, graded 0.

Pre- and post-shift spirometry was planned and done by a minority of the poultry workers. The data are not presented however, as the response rate was poor owing to suspicion on the part of workers that poor lung function results would lead to retrenchment.

Statistical methods

Differences in symptoms, atopy (a positive skin-prick test response to at least one common allergen), skin-prick test responses and antibody levels were tested for significance using the chi-square test for trend or the Mantel-Haenszel chi-square test. The association between respiratory symptoms and skin-prick test responses or antibody levels was tested using Kendall's correlation test.

Indices of exposure were intensity (unexposed controls, controls with possible exposure (e.g. subject plucked chickens at home), poultry workers with low, medium or high exposure); duration of employment by the poultry company (years); and a cumulative exposure index calculated for each worker by multiplying the number of months worked in a job by the level of exposure for that job, and then adding these products for all the jobs the worker had done. The least dusty job was assigned an exposure level of 1, and the other jobs either 4, 5 or 10 as shown in Table I. A cumulative exposure index was not calculated for controls.

Stepwise multiple logistic regression analyses were used to test the association between exposure category and respiratory symptoms, controlling for smoking and age. The level of significance used was $P \leq 0.05$.

RESULTS

A total of 134 poultry workers and 122 controls answered the questionnaire. All these workers and 120 of the controls were tested immunologically. The response rate for the poultry workers was 85.4% (134 of 157 workers). The controls were slightly older than the poultry workers (mean 40.8 and 34.8 years, respectively). Although statistically significant ($P < 0.001$), the mean difference of 6 years is unlikely to be clinically important. The smoking profiles of the controls and exposed workers were similar: smokers 55% and 59%; ex-smokers 23% and 19%; non-smokers 22% and 22%, respectively.

Symptoms

Respiratory symptoms and symptom complexes consistent with organic dust exposure are shown in Table II by exposure category. Remarkably, a trend of increasing symptom prevalence with increasing exposure category was evident for all the symptoms or symptom complexes in which the controls were used as the lowest category of exposure. 'Asthma 2' required symptoms to be present while working with chickens, so comparison with the controls was not appropriate. It is notable that a very high proportion of workers with higher exposure were symptomatic. Work-related symptoms were defined as those which were most noticeable at or after work, and which improved when the subject was on holiday.

It can be seen from Fig. 1 that the relationship between exposure and five symptoms cannot be explained by cigarette smoking, as exposed workers had all symptoms more frequently than unexposed subjects, regardless of smoking status.

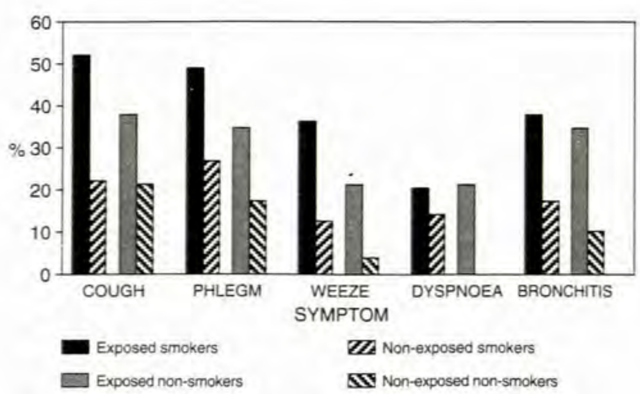

Fig. 1. Reported symptoms by smoking among exposed and non-exposed subjects.

Table II. Symptoms and symptom complexes in poultry workers and controls

	Controls (N =122)		Low (N = 26)		Medium (N = 55)		High (N = 53)		
	N	%	N	%	N	%	N	%	P
Cough	26	21	8	31	23	42	29	55	0.0000
Work-related cough	11	9	5	19	17	31	17	32	0.0000
Phlegm	26	21	8	31	24	44	25	47	0.0001
Work-related phlegm	7	6	3	12	19	35	16	30	0.0000
Wheeze	13	11	5	19	16	29	18	34	0.0001
Work-related wheeze	3	3	3	12	7	13	12	23	0.0000
Dyspnoea	15	12	4	15	11	20	15	28	0.0103
Work-related dyspnoea	5	4	3	12	6	11	7	13	0.0283
Fever	6	5	6	23	11	20	9	17	0.0052
Bronchitis*	17	14	6	23	19	35	21	40	0.0001
Chronic bronchitis†	9	7	3	12	11	20	9	17	0.0197
Asthma 1‡	3	3	1	4	7	13	6	11	0.0060
Asthma 2§	NA		4	15	14	26	13	25	0.4481
Asthma 3¶	5	4	3	12	6	11	7	13	0.0280
Symptom complex 1‖	30	25	12	46	37	67	40	76	0.0000
Symptom complex 2**	28	23	12	46	33	60	39	74	0.0335
Symptom complex 3††	2	2	2	8	6	11	4	8	0.0269
Eye irritation at work	1	12	7	24	24	44	31	59	0.0000
Skin irritation at work	9	7	1	4	11	20	11	21	0.0032
Nose irritation at work	6	5	3	12	25	46	22	42	0.0000

Exposure category: Low, Medium, High.

* Bronchitis = cough + phlegm.
† Chronic bronchitis = cough + phlegm for 3 months for 2 years.
‡ Asthma 1 = wheeze + night-time or early morning dyspnoea or chest tightness.
§Asthma 2 = dyspnoea or tight chest when working with chickens.
¶Asthma 3 = dyspnoea at or after work but not while on vacation.
‖Fever, sore joints/muscles, headaches, sickly or cough during or soon after a shift.
**Fever, sore joints/muscles, headaches or sickly during or soon after a shift.
††Fever, sore joints/muscles and cough during or soon after a shift.

In general, a slightly greater proportion of long-service (> 5 years) workers had symptoms than their short-service co-workers, but only 'asthma 1', defined as a wheeze with shortness of breath or tight chest at night or first thing in the morning, reached statistical significance: 14 workers, all of whom had > 5 years' service, had asthma 1 symptoms ($P = 0.0409$).

Poultry workers were categorised into one of the three cumulative exposure classes by dividing the cumulative exposure index into three roughly equal parts. Workers thus fell into a low (≤ 500), medium (501 - 1 000) or high (> 1 000) cumulative exposure class. Somewhat surprisingly, there was no trend between symptoms or symptom complexes (including chronic bronchitis) and cumulative exposure.

Immunological tests

The proportions of poultry workers and controls with at least one positive response to a common allergen were very similar, viz. 28.4% and 26.7% respectively. House-dust mite responses are of particular interest given the possibility for cross-reactivity with storage mite.[13] Although more workers than controls had a positive skin-prick test to house-dust mite, the difference was not significant (24.6% v. 16.7%; $P = 0.1198$).

There was tentative evidence that atopic workers were selected out of the workforce, because the prevalence of workers with at least one positive skin-prick test reaction declined with increasing years of service, although not significantly: 38.5%, 30.8% and 21.4% of poultry workers with 0 - 5 years, 6 - 10 years and > 10 years of service, respectively, were atopic ($P = 0.0974$).

Table III shows immunological test results by exposure category for the 134 exposed subjects and the 120 controls who were tested. Although skin-prick reactions to poultry-related agents were uncommon, it is notable that they occurred exclusively in either domestically or occupationally exposed individuals. Positive immunodiffusion tests for feathers and serum were more common in exposed than non-exposed subjects but, surprisingly, less common for feed. IgE antibodies to chicken faeces were detected in 6.7% of poultry workers and 0.8% of controls ($P = 0.0088$). Unexpectedly, significantly more of the unexposed individuals than of the exposed workers had detectable IgE antibodies to chicken serum ($P = 0.0101$). There were no significant differences between the exposed and unexposed groups for any of the IgG antibodies.

Certain symptoms and symptom complexes may have arisen through immunologically mediated conditions, for example wheeze due to asthma as a consequence of sensitisation to poultry feed. To examine this possibility the immunological profiles of poultry workers with and without selected symptoms and symptom complexes were compared. The results are shown in Table IV. The serum, faeces, feathers and feed tests are grouped together to simplify presentation. The only significant association occurred between a positive immunodiffusion test and absence of asthma as defined by wheeze with night-time or early-morning chest symptoms.

Table III. Immunological tests related to intensity of exposure to poultry agents

	Controls				Poultry workers						
	No exposure (*N* = 87)		Possible exposure* (*N* = 35)		Low (*N* = 26)		Medium (*N* = 55)		High (*N* = 53)		
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*P*
Skin-prick tests											
Serum	0		2	5.7	0		0		2	3.8	0.6464
Faeces	0		2	5.7	0		2	3.6	1	1.9	0.5520
Feed	0		2	5.7	0		0		1	1.9	0.4585
Feathers	0		2	5.7	0		0		1	1.9	0.4585
Immunodiffusion tests											
Serum	10	11.8	4	11.4	4	15.4	8	14.5	20	37.7	0.0008
Faeces	9	10.6	7	20.0	3	11.5	7	12.7	9	17.0	0.4514
Feed	8	9.4	3	8.6	0		0		2	3.8	0.0241
Feathers	8	9.4	1	2.0	10	38.5	28	50.9	14	26.4	0.0000
IgE											
Serum	5	5.9	1	2.9	0		0		0		0.0101
Faeces	1	1.2	0		2	7.7	1	1.8	6	11.3	0.0088
Feed	2	2.4	1	2.9	1	3.8	1	1.8	2	3.8	0.7511
Feathers	2	2.4	2	5.7	1	3.8	0		3	5.7	0.7340
IgG											
Serum	3	3.5	2	5.7	0		6	10.9	3	5.7	0.2507
Faeces	5	5.9	2	5.7	0		5	9.1	3	5.7	0.7610
Feed	2	2.4	1	2.9	1	3.8	2	3.6	3	5.7	0.3157
Feathers	3	3.5	4	11.4	0		2	3.6	2	3.8	0.7064

* No occupational exposure, but possible domestic exposure as chickens plucked or kept at home.

Multivariate analyses

To confirm that respiratory symptoms were independently associated with exposure to poultry agents, and not a consequence of smoking tobacco or age, multivariate analyses using logistic regression were done. The dependent binary variables were cough, phlegm, wheeze, breathlessness, chronic bronchitis, or asthma. Exposure was entered into the model as exposure category, smoking was in pack-years (i.e. the product of the number of years smoked and the number smoked per day divided by 20), and age was in years. Table V shows that, in general, the highest adjusted odds ratios were obtained for workers in the most exposed category, and that a significant adjusted risk was present for all the symptoms and symptom complexes.

Discussion

The major objective of this study, to describe the respiratory health of poultry workers, was limited by the reluctance of workers to perform spirometry. Nevertheless, the high prevalence of symptoms, absolutely and relative to the controls, and the bivariate and multivariate exposure-response relationships provide convincing evidence of important work-related health effects. These findings are consistent with the literature, and there can be little argument that improved hazard control and monitoring of workers are warranted. The variety of symptoms and symptom complexes reported by these workers, and the complex nature of exposures on poultry farms, should not inhibit simple pragmatic measures to reduce workplace dustiness.[4]

Occupational or work-related asthma is a consideration in poultry workers: Bar-sela and colleagues[12] found work-related symptoms consistent with asthma in 14 poultry workers, one of whom was sensitised to northern fowl mites and had a positive bronchial provocation test to this ectoparasite. Asthma had been diagnosed in 10.7% of Victoria broiler growers compared with 5.7% among adults in South Australia,[5] and 5.3% of poultry feed workers had symptoms of occupational asthma.[8] In contrast, Donham *et al.*[14] found little evidence of asthma in 257 US poultry workers and, although asthma symptoms such as wheeze or chest tightness are notable complaints, occupational asthma in poultry workers has been demonstrated infrequently when convincing methods such as specific provocation testing have been used.

In this study cases of occupational asthma were not identified objectively. Nevertheless, wheeze has been shown to be a relatively sensitive symptom for predicting bronchial hyperresponsiveness, and waking at night with shortness of breath and morning tightness has been shown to be relatively specific.[15] Work-related wheeze was reported by 22.6% of the

Table IV. Skin-prick tests, immunodiffusion, IgE and IgG results in poultry workers with and without selected symptoms and symptom complexes

	Positive immunological test							
	Skin-prick test (*N* = 5)		Immunodiffusion (*N* = 79)		IgE (*N* = 13)		IgG (*N* = 22)	
	N	%	*N*	%	*N*	%	*N*	%
Wheeze								
Yes (39)	2	5.1	20	51.3	2	5.1	5	12.8
No (95)	3	7.7	59	62.1	11	28.2	17	17.9
*P**	0.4546		0.2491		0.2091		0.4730	
Work-related wheeze								
Yes (22)	0		15	68.2	0		3	13.6
No (112)	5	4.5	64	57.1	13	11.6	19	17.0
P	0.4108		0.3377		0.0859		0.4917	
Asthma 1†								
Yes (14)	0		4	28.6	2	14.3	3	21.4
No (120)	5	4.2	75	62.5	11	9.2	19	15.8
P	0.5708		0.0150		0.4052		0.4124	
Asthma 2‡								
Yes (31)	0		14	45.2	3	9.7	6	19.4
No (103)	5	4.9	65	63.5	10	9.7	16	15.5
P	0.2622		0.0760		0.6497		0.6159	
Asthma 3§								
Yes (27)	0		16	59.3	3	11.1	6	22.2
No (107)	5	4.7	63	58.9	10	9.3	16	15.0
P	0.3184		0.9714		0.5099		0.2599	
Hypersensitivity pneumonitis¶								
Yes (12)	1	8.3	5	41.7	1	8.3	0	
No (122)	4	3.3	74	60.7	12	9.8	22	18.0
P	0.3791		0.1663		0.6717		0.1048	

* P = Mantel-Haenzel χ^2.
†Asthma 1 = wheeze + night-time or early morning dyspnoea or chest tightness.
‡Asthma 2 = dyspnoea or tight chest when working with chickens.
§Asthma 3 = dyspnoea at or after work but not while on vacation.
¶Fever + sore joints or muscles + cough, during or soon after a shift.

high-exposure category of workers and by only 2.5% of controls. Similarly, poultry-specific asthma symptoms of wheeze plus either dyspnoea or tight chest at night or on waking occurred in 8.8% of high-exposure workers (asthma 1, Table II). It could be said that an estimate of work-related asthma prevalence in the high-exposure category is in the order of 20% (most sensitive) to 8.8% (more specific), but this estimate must be tempered by the fact that a variety of symptoms, including chest tightness and increased airway responsiveness, are common to asthma and a number of other conditions caused by organic dust.[3,4] In this kind of population, asthma cannot be diagnosed confidently without measurement of bronchial responsiveness; what can be concluded from our study is that a careful search for poultry workers with occupational asthma is indicated.

The investigation of the relationship between immunological parameters and either exposure or symptoms was unrewarding in that a test or battery of tests likely to be useful in monitoring workers was not identified. Immunodiffusion tests, particularly for serum and feathers, were positive in a large proportion of poultry workers, but also in around 10% of 'no exposure' controls (Table III). No test, including immunodiffusion, was significantly more commonly positive in symptomatic than asymptomatic workers (Table IV), pointing to exposure rather than disease as the explanation for a positive test. This inference is in contrast to the findings of some other studies. Workers in whom a skin-prick test was positive for poultry food dust were found to have more respiratory symptoms than their negative co-workers in a study by Zuskin and colleagues.[8] They had a more stringent criterion for a positive skin-prick test, namely a 3 mm reaction (we used any reaction larger than the negative control), but this criterion cannot account for the differences in the findings, since only one worker in our study had a positive skin-prick test to poultry feed (Table III). It

Table V. Adjusted* relative risk of respiratory symptom or symptom complex in poultry workers

Symptom	Exposure category	Odds ratio	95% confidence interval	*P*-value
Cough	Low	1.44	0.65 - 3.21	0.372
	Medium	1.99	1.12 - 3.57	0.022
	High	2.65	1.47 - 4.76	0.001
Wheeze	Low	1.75	0.62 - 4.94	0.287
	Medium	2.68	1.25 - 5.75	0.012
	High	3.46	1.59 - 7.52	0.002
Dyspnoea	Low	1.27	0.42 - 3.82	0.675
	Medium	1.56	0.67 - 3.59	0.301
	High	2.93	1.32 - 6.55	0.009
Fever	Low	4.39	1.40 - 13.72	0.011
	Medium	3.79	1.37 - 10.49	0.011
	High	3.29	1.11 - 9.78	0.032
Chronic bronchitis	Low	1.57	0.42 - 5.80	0.502
	Medium	2.88	1.14 - 7.28	0.025
	High	2.86	1.04 - 7.90	0.042
Asthma†	Low	1.52	0.16 - 14.72	0.716
	Medium	5.13	1.25 - 20.98	0.023
	High	5.04	1.12 - 22.61	0.035

* Adjusted for age and pack-years of cigarette smoking.
†Asthma = wheeze + chest tightness or dyspnoea at night or first thing in the morning.

should be noted that 28.4% of poultry workers in our study had a positive skin response to a common allergen, so under-reading of positive skin-prick tests to poultry-related allergens is unlikely to have occurred. Muller and colleagues[16] found precipitating antibodies in 22% of 339 poultry farmers, and that the number of persons with antibodies and respiratory symptoms was higher in more dusty departments. Our study found that immunodiffusion positivity was associated with exposure but not with increased symptoms (Tables III and IV). Abattoir workers exposed to chickens and ducks have been shown to have significantly higher poultry-specific serum antibody levels than blood donors.[17] This finding is not surprising, given that the controls were presumably not exposed to poultry and, therefore, not likely to develop antibodies. No relationship was found between the occurrence of antibodies and respiratory symptoms.

Bar-Sela and co-workers[12] found that 14 of 16 symptomatic poultry workers had skin reactivity and/or elevated specific IgE antibodies to a poultry antigen. The rate in the controls is not presented in the paper, although none of 12 controls had a positive skin-prick test. The most striking feature of their study is that 13 of the 14 symptomatic workers were positive to Northern fowl mites, either exclusively or in combination with other antigens. It is unfortunate that we did not include mite antigens in our study. The Bar-Sela study[12] should be read with the study design in mind however: the 16 poultry workers were selected because they had symptoms, and whichever immunological parameter occurred frequently would therefore be associated with symptoms. Since no asymptomatic poultry workers were included as controls (although 12 poultry veterinarians were), the positivity rate for Northern fowl mites in asymptomatic workers is not known; if it were also high it would, of course, reduce the value of a positive test. Precipitins to chicken serum or chicken-dropping extract were found in 27% of 58 poultry farmers, but none had symptoms characteristic of hypersensitivity pneumonitis,[18] a finding in keeping with our results.

In summary, previous studies have shown an association between disease and skin-prick reactions or specific IgE to poultry feed or Northern fowl mite. Others, including this study, have shown that immunological parameters are associated with exposure but not with symptoms and diseases. A number of possibilities, besides a true lack of association, could explain our findings. Firstly, workers with serious immunological conditions (e.g. hypersensitivity pneumonitis) might have been preferentially selected out of the workforce, leaving a survivor population for cross-sectional study. Secondly, the complex nature of the exposure and multiple possible disease mechanisms could obscure the conditions associated with allergy or hypersensitivity in the much larger pool of non-immunologically related conditions. This is an important possibility, given that irritants,[1] endotoxins[6,3] and nonspecific inflammation[10] have been linked to symptoms in poultry workers. Thirdly, we might have omitted important antigens (mites make the point). Whatever the explanation, from the perspective of occupational medicine practice this result is disappointing, since tests of sensitisation have proved very useful in other settings, platinum refining being a salutary example. Possibly it is unrealistic to expect that tests of sensitisation will be useful monitoring tools in settings with multiple exposures and disease mechanisms: implicit is a battery of tests, so false-positives, which are particularly important in occupational medicine practice, become a consideration. Rylander's[4] warning that hypersensitivity or allergic reactions should not be considered the only relevant effects of organic dust, and that patients with negative tests for allergy should not be marked as complainers or as suffering from exaggerated symptoms, is well given.

In conclusion, in common with other studies we found a very high prevalence of symptoms in poultry workers; improved hazard control is strongly indicated. Tests of allergy and hypersensitivity were associated with exposure, but not with disease. Useful tests of sensitisation have not been excluded; a prospective study design is likely to be more rewarding than the cross-sectional approaches we used in this study. A cohort of new recruits should be studied, and if cohort members develop asthma with work-related airflow variability they should have specific challenges to identify causative agents. An industry-wide project, rather than an individual company initiative, may encourage participation by workers and management, since anxieties related to possible job loss and other issues could be negotiated at an industry level.

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