Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola

ISSN 1516-635X Jan - Mar 2004 / v.6 / n.1 / 23 - 29

Respiratory Risks in Broiler Production Workers

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Keywords

Occupational health, pulmonary diseases, rural worker, poultry production.

Acknowledgments

The authors wish to thank FAPESP and DAGRANJA company for supporting this research.

Arrived: march / 2003
Approved: january / 2004

ABSTRACT

There are many situations that involve health risks to the Brazilian rural worker, and animal production is just one of them. Inhalation of organic dust, which has many microorganisms, leads in general to respiratory allergic reactions in some individuals, "asthma-like syndrome", and mucous membrane inflammation syndrome, that is a complex of nasal, eye, and throat complaints. Furthermore, workers might have farmer's hypersensitivity pneumonia, that is a respiratory health risk along the years. The objective of this study was to evaluate the potential pulmonary health risks in poultry production workers in the region of Curitiba, PR, Brazil. Interviews using a pre-elaborated questionnaire with 40 questions were made with 37 broiler production workers, which were submitted to a pulmonary function test. Results of restrictive function with lower FEV_1 (the maximum respiratory potential, the forced expiratory volume in the first second of exhalation) and FVC (forced vital capacity) represented 24.32% of the total of workers, and severe obstruction represented 2.70%. Other symptoms were found in 67.57% of the workers as well. The results showed that those who work more than 4 years and within more than one poultry house, exceeding 5 hours per day of work, presented higher pulmonary health risks. It is concluded that the activities within broiler houses may induce allergic respiratory reaction in workers. The use of IPE (individual protection equipment) besides special attention to the air quality inside the housing may be advised in a preventive way.

INTRODUCTION

Rural work might affect labor health in different ways. Persons in general that work with agriculture are often exposed to risks such as: heat stress, moisture, agrochemicals and other. Dust in animal housing and/or chemicals might cause inhalation of particles and vapors that lead to respiratory diseases. Among these problems, lung damage is often seen due to aggressive germs, air pollutants, vapors and dangerous gases (Mutel & Donham, 1983).

Dust in animal housing results from poultry residues, molds and feather and may produce immune response against pathogenic biological agents. The response can be acute, recurrent or chronic in the lungs, depending mainly on the frequency and level of exposure. Agents named contaminants are found in suspension in airborne particles and play an important role as allergenic elements to humans. Despite the fact that rural areas are known as healthier than urban areas, the lack of proper access to basic health services is still a factor of disadvantage, leading to primary labor risks (Higgs *et al.*, 1998). Decisions on labor security and health are generally more difficult to be standardized or applied in rural areas than in urban areas.

Silos and animal confinement may represent respiratory risks because of dust presence as well. Several respiratory problems are generally seen, such as the *asthma-like syndrome*, the so-called *farmer´s lung*, or yet the *silo filler´s disease* (Kirkhorn & Schenker, 2002). Airway inflammation caused by a non-allergic mechanism has been well documented in the literature as the major respiratory health problem of people working in animal confinement buildings with heavy dust exposure, especially in swine and poultry productions (Olenchock, 1982; Mutel & Donham, 1983; Rylander, 1986; Melbostad *et al.*, 1997; Iversen *et al.*, 2000; Kirkhorn & Garry, 2000). Hypersensitive lungs have been related to inhalation of mold spores (Mutel & Donham, 1983), whereas a general respiratory function decline has been reported in rural workers along with the number of working years (Kirkhorn, 2002).

It has also been demonstrated that dust exposure is associated with an accelerated decline in FEV (forced expiratory volume in the first second of exhalation) in farmers working in completely closed swine housing in areas of temperate climate. The loss of FEV approximately doubled in most workers, causing significant lung disease (Iversen *et al.*, 2000). In broiler production, dust in suspension is generally found in association to fungi such as *Penicillium sp, Aspergillus sp, Fusarium sp, Coletotrichum sp*, among others, and some of these have allergenic potential. Thus, dust in poultry houses carries an inherent respiratory risk. Generally, dust particles are removed by cough, mucociliary cleaning, fagocytosis or lymphatic transport, and will not necessarily reach the alveolar region. Respiratory particles are defined as having in average 4.0 µm or less (Kirkhorn & Garry, 2000). Based on published data, poultry industry workers were exposed to an average dust level of 11.53 mg/m³.

Recommended indoor dust limits are extensively covered in international literature (AGCIH, 1980; NIOSH, 1966; Ellen *et al.*, 1999). Lung effects occur even when total dust level is below 2.4-2.5 mg/m³ and inhaled dust level reaches 0.23 mg/m³ in swine housing (Donham, 2000). Total dust of 2.4 mg/m³ and an inhaled dust value of 0.16 mg/m³ were found in poultry houses in temperate climate. Donham (2000) and Kirkhorn (2002) pointed to the importance of reviewing dust limits in animal housing that should be considered under temperate climate. Composition of dust sedimentation in poultry, cattle and swine production consists of 85% organic matter, whereas *Staphylococcus* and *Streptococcus* are found in 80% of the air. In broiler houses, several species of fungi were found to have allergenic potential (Hartung & Seedorf, 1999). Dust samples were collected weekly in two broiler houses in Brazil and the following species of the genus *Aspergillus* were found: *A. niger*, *A. parasiticus*, *A. candidus*, *A. flavus*, *A. nidulans A. fumigatus* (Baracho & Nääs, 2002).

Exposure to organic dust may influence the reactive bronchial response, reducing FVC (forced vital capacity) and FEV. Important information about air flow resistance during forced exhalation can be acquired by determining the speed with which the air leaves the lungs during a FVC maneuver. A FEV smaller than the expected value (which varies regarding age, height or gender) indicates abnormal air flow resistance. Obstruction symptoms suggest breathing obstruction and pulmonary hyper-distension, and it can be diagnosed if respiratory air flow is considerably smaller than the expected for a certain pulmonary volume (Silveira, 1998).

Labor health risk in swine production was evaluated by measuring FVC as well as FEV in workers exposed to the environment before and after working hours (Cormier *et al.*, 2000). Both FVC and FEV decreased after exposure to the environment of swine housing, and it was concluded that the modern closed swine housing was not successful in providing a good labor environment. Zuskin *et al.* (1995) measured lung function in 343 poultry farm workers. FEV and FVC were significantly lower than the predicted, and workers exposed for more than 20 years had lower lung function than workers subjected the poultry house environment for less time.

Exposure to organic dust for three hours influences the symptoms of reactive chronic bronchitis, reducing values of FVC and FEV from 3 to 6% immediately after exposure to dust, with a gradual increase after the 1st to the 4th week (Sundblad, 2002). Kirkhorn & Schenker (2002) described the association between organic dust within animal housing and diseases such as chronic bronchitis, toxic organic dust syndrome and sinus problems. Melbostad *et al.* (1997) stated that the most important exposure factors that may lead to chronic bronchitis in farm labor is the close contact to animals (horse, swine and broilers) and their housing dust.

Considering the large number of persons that work in the Brazilian poultry production, the objective of this study was to estimate the potential respiratory risks of workers engaged in tasks performed within poultry houses.

MATERIALS AND METHODS

This is a case study done in a commercial intensive broiler farm located at latitude 25°25' S and longitude 49°17' W, and approximate altitude of 934 m, from November to December 2002. During this trial, average limits of maximum and minimum dry bulb temperatures were 24-27 °C and 12-15 °C, respectively, average relative humidity was 80-90%, and average rain index was 80-160 mm. All studied farms were integrated to the system of poultry production where workers owned the land and animal housing, and raised the broilers for a company that provided animal feeding and one-day-old chicks. The broiler houses consisted of wooden beam and poles and roof of ceramic tiles with low degree of mechanization. Metallic screen surrounded the open sides and curtains were used on the laterals. Curtains were washed every three growing cycles. In the first three weeks, heating was on and inside curtains were closed constituting an internal cell. Bedding material was predominately chopped pine. Technical supervision was provided weekly and the birds where slaughtered at 7 weeks of age. Tasks were predominantly manual, including control of inside temperature according to the growing stage by the management of outside and inside curtains, as well as cleaning and filling drinkers and feeders, and revolving the litter. In this study, 25 broiler houses were visited and 37 workers from both genders were evaluated (45.9% female and 54.1% male). Ages varied from 16 to 51 year-old and time of employment in poultry production was up to 5 years.

The evaluation consisted of two parts: first, there was a selection within the families of workers to identify who was involved directly and daily with tasks within the animal houses and, second, a questionnaire with 40 questions was answered by the selected persons. Information included anamnesis; time (years) involved in the present activity; total hours of daily work; tasks effectively performed; average time spent during tasks; time spent within the animal houses; detailed description of the performed tasks (cleaning of drinkers, cleaning of feeders, revolving the litter, cleaning of lateral screen and curtains and loading feeders); description of the protection equipment used during such tasks; detailed information about the dust, their perception of the dust and the relation of such perception and the weekly sinus symptoms; their perception of other symptoms (stomachache, sore and itching eyes, cough, lack or failing of breathing, itching skin, sore legs, and sore throat); if smoker, the number of cigarettes smoked per day or, if previously a smoker, when stopped smoking; if presented any respiratory problem ever before (asthma, chronic bronchitis, or other symptoms); and finally, which activity was performed previously and respiratory risks that this activity might imply, as well as the level of satisfaction at work.

A total of 37 workers were randomly selected for the trial, among those who did not work directly with agrochemicals. After answering the questionnaire individually, the worker was instructed to perform the respiratory test using the equipment Pony Spirometer-Cosmed. Mod. PNY87, using disposable mouthpieces. Previously to the test, the following data were input: name; gender; age; weight (corporal mass in kg measured with a calibrated digital scale Plenna Mod.RO42000); and height (measured in cm at standing position). The methodology used for this part of the respiratory test was as suggested by Fernandes Filho (1999). The test allows the record of both respiratory volumes: breathing capacity and pulmonary flux. From the recorded data, the following parameters are obtained: forced vital capacity (FVC), which is the maximum respiratory forced potential; forced expiratory volume in the first second of exhalation (FEV1); ratio between these (FEV_1/FVC), which determines if there is any restrictive/obstructive impairment of the lung function; and forced respiratory flow between 25 and 75% of the FVC curve ($FEF_{25-75\%}$), which determines the respiratory area of obstruction.

After data recording, the worker was oriented to breathe in and out through the mouthpiece in order to determine the current inhaled volume of air and the respiratory frequency. The FVC was also determined by deep inhalation up to the total pulmonary capacity (TPC) and exhaling the maximum volume of air possible after a command. Determination of the speed of incoming air from the lungs during FVC evaluation gives important information about the flux resistance during the forced exhalation.

Dust particles were not measured. There was no preliminary personal medical history available for any of the individuals in the trial. The test was repeated a second time (number of repetitions = 2), when there was error due to doubtful use of the equipment or when the equipment showed some mistaken data. Tests were performed during the last two working hours for all individuals in the trial. Data from both the questionnaire and the pulmonary test were statistically analyzed using the Chi-square test. Association between results from different sources was made using the Odds

Ration, in order to determine the significance of the implied risk.

RESULTS AND DISCUSSION

Among the evaluated workers, 43.24% of them performed tasks in two or more broiler houses. Tasks were evaluated during phase 1 (from one-day-old until the 3rd week of bird age) and phase 2 (from the 3rd week until bird slaughter age). The percentage of workers performing tasks for more than 5 hours/day was 54.05% in phase 1 and 32.43% in phase 2. The answers indicated that the workers spent an average 5 hours inside the poultry houses. The respiratory test provides the individual value and also a predicted value considering the data input before the test.

Tasks throughout the broiler growth cycle were predominantly manual, consisting of: temperature control using gas or wood heaters; filling and cleaning drinkers and feeders and daily litter revolving. Such activities inside the houses resulted in a large amount of dust in suspension in the environment. This fact led to respiratory risk after the 3rd week of growth, mainly during the winter, according to the perception of the workers, as a result of the closed curtains and the low relative humidity caused by the use of heaters. Workers generally did not use any individual protection equipment (IPE). The results of each examination are shown in Table 1.

The pulmonary tests from 37 workers showed that 24.32% of them had light restriction with decrease in FEV (forced expiratory volume in the first second of exhalation) and FVC (forced vital capacity); and 2.70% had severe obstruction, whereas 72.98% showed normal pattern. This percentage of mild restrictive symptoms implies that allergenic factors existed and led to risk attributable to the exposure. Afterwards, an association between the data of pulmonary tests and the number of houses in which the workers performed tasks was evaluated. For such analysis, the data obtained were classified as normal and abnormal (with any kind of respiratory restriction or obstruction) (Table 2).

The p-value verified in the statistical analysis shows that there was an association between the two dependent variables. The association between the number of houses in which the workers performed tasks, and the data of pulmonary tests was significant at $\alpha = 0.05$. The Odds Ratio was [(OR = (7/3)/(9/18)] 4.667, with a p-value of 0.014 in the monocaudal test. This implies that workers performing tasks in more than one house have 4.667 more chance of presenting altered results in the respiratory test than other, at a significant level of $\alpha = 0.05$. The relationship between the pulmonary test and the number of houses where the workers performed tasks showed that 85.71% of the workers performing tasks in one house had normal data, while 56.25% had normal data working in more than one house. It was seen that the worker who performed tasks in more than one house was most exposed to respiratory risk of diseases ($p = 0.04$).

The correlation between the workers who performed tasks in more than one house and for over a year was also evaluated, since Iversen *et al.* (2000) and Donham *et al.* (2000) stated that there is a reduction in pulmonary function proportional to the number of years of labor within animal housing. The analysis revealed a positive correlation between pulmonary data and the number of houses at which the workers performed tasks and, at the same time, for over 4 years. It is seen in Table 1 that 16 workers performed tasks in more than one house, independent of the number of working years, while 2 workers had less than 4 years of labor. Such data, including the variable "number of working years", are shown in Table 3. Higher pulmonary health risks ($\alpha = 0.05$) were found in those who worked more than 5 hours a day.

The p-value of the Chi-square test shows the dependent association of those two variables (number of animal houses and number of years). This means that the association between the pulmonary test and workers performing tasks both for more than 4 years and in more than one broiler house is statistically significant at the level of $\alpha = 0.1$. The Odds Ratio was [(OR = (6/4)/(8/19)] 3.56, with p-value of 0.016 in the monocaudal test. This implies that the worker who performed tasks for more than 4 years and in more than one broiler house has 3.56 more chance of having an altered result in the pulmonary test than any other worker in a distinct category, at a significant level of $\alpha = 0.05$. This also indicates that individuals working over 4 years in more than one house (i.e., overlapping 5 hours of work/day inside the houses) are exposed to the highest respiratory risk (Table 4).

For the association of the number of symptoms and the results of the pulmonary tests, it was considered the presence of one of the symptoms (cough, sneezes, sore throat) and the frequency that those symptoms were found weekly. Kirkhorn (2002) considers that there is a syndrome called "irritation of mucous membrane" that leads to a range of other symptoms in the area of the eyes, nose and throat, that is commonly found among workers who perform tasks

Table 1 - The printed data of workers with altered (restrictive/obstructive) lung function.

Worker number	Age (year)	Gender	Height (cm)	Weight (kg)	FVC	Pred.	%	FEV1	Pred.	FEV1/FVC%	FEF 25-75%	Final Result
2	16	M	1.72	58.2	3.55	4.35	82	3.55	3.77	100.0	4.32	Mild restriction
5	41	M	1.64	61.8	2.97	4.04	74	2.95	3.37	99.3	5.46	Mild restriction
9	39	F	1.67	71.9	2.97	3.49	85	2.77	3.02	93.3	2.93	Mild restriction
13	35	F	1.53	51.8	1.94	2.98	65	1.03	2.57	53.1	0.15	Severe obstruction
14	18	F	1.62	59.3	2.97	3.82	78	2.55	3.35	85.9	2.83	Mild restriction
20	36	M	1.73	96.4	3.77	4.69	80	3.55	3.91	94.2	5.23	Mild restriction
29	32	M	1.69	79.8	3.37	4.56	74	3.29	3.85	97.6	4.12	Mild restriction
32	32	M	1.66	56.9	3.26	4.39	74	3.26	3.72	100.0	6.54	Mild restriction
33	51	M	1.68	55.2	3.00	4.01	75	3.00	3.26	100.0	5.36	Mild restriction
36	27	M	1.82	63.8	4.58	5.44	84	4.40	4.55	96.1	5.40	Mild restriction

Table 2 - Association between the number of broiler houses where the workers performed tasks and pulmonary test results.

Number of houses/day	Pulmonary test data		
	Altered	Normal	Total workers
1	3	18	21
More than 1	7	9	16
Total of evaluated workers	10	27	37

Chi-square=3.997; DF = 1; p -value = 0.046.

Table 3 - Association between the time of labor and tasks performed in more than four broiler houses, and pulmonary test results.

Working more than 4 years and in more than 1 broiler houses	Pulmonary test data		
	Altered	Normal	Total workers
Yes	6	8	14
No	4	19	23
Total of evaluated workers	10	27	37

Chi square = 2.862; DF = 1; p - value= 0.091.

Table 4 - Association between the number of symptoms and pulmonary test results.

Number of symptoms	Pulmonary test data		
	Altered	Normal	Total workers
1 or more	9	16	25
None	1	11	12
Total of evaluated workers	10	27	37

Chi-square= 3.147; DF = 1; p - Value = 0.076.

inside animal housing. Donham *et al.* (1989) reported that the occurrence of sinus symptoms is higher than 50%, whereas sinus irritation is higher than 25% in individuals working inside swine housing.

As shown by the p-value, variables are dependent and the association between the variables (number of symptoms and respiratory risks) is significant at $\alpha = 0.1$. This means that workers with more than one symptom have a higher statistical chance to show an altered pulmonary test result (light or severe obstruction). The Odds Ratio was [OR = (9/1)/(16/11)] 6.18, with a p-value of 0.0749 in the monocaudal test. This implies that individuals with one or more symptoms present, statistically, 6.18 times higher chance of showing altered results in the pulmonary tests, at a significant level of $\alpha = 0.10$. As the symptom is reported weekly, it is then highly related to working conditions. Workers complained that they "often had a cold", without stating any specific correlation with the exposure to organic dust. Those that had restrictive or obstructive pulmonary test often had also more than one symptom in a week (sneezes, cough and sore throat).

The association between smoking condition and results of the pulmonary test was studied (Table 5). The p-value shows that these two variables are independent, as it was not significant at $\alpha = 0.1$. However, the Odds Ratio was [OR = (4/6)/(5/22)] 2.933, with a p-value of 0.05 in the monocaudal test, impling that smokers have statistically 2.933 times more chance to obtain an altered pulmonary test than among non-smokers. Among the evaluated workers, 24.32% were smokers and had been smoked for over 10 years, smoking in average 18 cigarettes/day. Despite the fact that no positive association between the smoking habit and the results from the pulmonary test was found, the results indicated that smokers do have higher chances of respiratory risk incidence than non-smokers, when working in poultry houses. This result corroborates results reported by Melbostad *et al.* (1997), who reported increasing respiratory health risk in frequent smokers that worked in close contact with intensive animal housing.

Confronting the evaluated activities with other tasks performed within the farm, 59.46% of the workers said that they had never been exposed to agrochemicals,

Table 5 - Association between the smoking habit and pulmonary test.

Smoker	Pulmonary test data		
	Altered	Normal	Total workers
No	6	22	28
Yes	4	5	9
Total of evaluated workers	10	27	37

Chi-square = 1.829; DF = 1; p -Value = 0.176.

while the remaining 40.54% were involved in distinct tasks that were not related specifically to crop cultivation. Some of the mentioned tasks were harvesting, domestic tasks (32.43%), cattle care, and equipment cleaning, transportation and maintenance. None of the evaluated workers used individual protection equipment, especially masks, for any of the tasks within the broiler houses, such as filling the feeders, drinkers or litter revolving. Workers exposed to organic dust should wear individual respiratory protection equipment (masks) to assure safety while performing tasks, considering that possible respiratory risks exist. Since the level of dust increases in the 3rd week of housing, prevention is essential and the correct use of individual protection equipment must be explained to workers. Information about respiratory risks should be presented to the workers, as there were infants sleeping inside the broiler houses, and were thus being exposed to organic dust at an early age.

There was no statistical correlation between gender and respiratory test results, or yet, between the workers and the time spent in either phase 1 or 2, when evaluated separately.

Workers also complained about other symptoms such as body itching, sore legs and low back pain. The workers were apparently not aware of the respiratory risks that organic dust might represent to them, even though they generally agreed that there was too much dust inside the houses while they performed certain tasks, such as: litter revolving and pouring the feed into the feeders. Cold-like symptoms associated to sneezes, sore throat and cough were seen in the evaluated workers and also described by them.

CONCLUSIONS

The present study showed that workers performing tasks within poultry houses with low degree of mechanization for over 4 years presented FEV and FVC significantly lower than the predicted values. It is advisable that average labor time within the houses is no longer than 5 hours/day. It was also found that the smoking habit in broiler workers may increase chances of respiratory risk as well.

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