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Original Article

Respiratory Hazards to Occupational Exposure of Poultry Dust in Poultry Farm Workers in Northern India

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Abstract

Background: Occupational exposure of farmers are known to cause many respiratory illness and manifest greater rates of asthma and respiratory symptoms than other workers. The poultry farm workers are exposed to organic dust, endotoxins and hazardous gases. Longer the duration of exposure to the dust, greater the health hazard. Therefore, the objective of this study was to record and compare the various pulmonary function parameters in poultry farm workers on the basis of duration of exposure to poultry dust. Methods: The study was conducted on 66 poultry farm workers after taking written informed consent. Pulmonary function tests was performed using Autospirometer (Helios 701: Chandigarh). The workers were grouped according to duration of exposure into five sub groups (Group A upto 5 years, Group B >5-10 years, Group C >10-15 years, Group D >15-20, Group E >20 years exposure). Data was analyzed using one way ANOVA and post-hoc by Bonferroni test. Results: We found that the pulmonary functions started deteriorating gradually in poultry farm workers after 5-10 years of exposure (Group B) to poultry dust with maximum decrease on exposure to more than 20 years (Group E). There was statistically significant decrease in FVC, FEV0.5, FEV1, FEV3 with normal FEV1/FVC suggesting restrictive ventilatory changes in poultry workers. There was significant decrease in FEF25-75% and FEF0.2-1.2, PEFR suggesting early small and large airway obstruction respectively. Conclusion: Poultry dust adversely affects the respiratory function and this impairment is associated with duration of exposure to poultry dust. The present study intends to raise public awareness about occupational exposure to poultry dust in poultry farm workers.

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Introduction

Livestock and poultry sector is a powerful sub sector of the agriculture in the economy of India. The poultry sector has shown a continuous expansion with poultry population reporting an annual growth rate of 12.39% (2007-12) (1). It provides employment to large number of people and contributes to the socioeconomic development of the country (2).

The poultry farm workers work predominantly within farm buildings such as, layers, brooders, broilers, hatcheries and are involved in a number of activities such as caring of the birds, feeding them, cleaning and maintenance of poultry farm (3, 4). They are constantly exposed to organic dust, endotoxins, hazardous gases, airborne fungi, fungal spores, bacteria, mites, dander, feathers and faecal materials (5, 6). Particulates and suspended dust present in the environment of poultry confinement buildings have size ranging from 1-10 microns in diameter. These dust particles are easily absorbed from the lung alveolar epithelium into the blood (7, 8). The endotoxin concentration correlates highly with the bacterial levels ($r=0.69$, $p<0.01$) (9). Larger particles get deposited in the upper and lower airways. The irritating gases like ammonia, hydrogen sulphide penetrate deep inside the lungs and enhance the toxic effects.

The dust particles get accumulated on continuous exposure and over a period of time have deteriorating effects on poultry's workers health. Exposure to poultry dust in poultry facilities lead to development of many clinical diseases such as allergic and non allergic rhinitis, (10) organic dust toxic syndrome (ODTS), (11) bronchitis, (12) asthma and asthma like syndrome (9). Bronchitis and hypersensitivity pneumonitis (8). They may have persistent respiratory symptoms like cough, nasal irritation phlegm, tightness of chest, dypnoea, pneumonia and progressive decline in lung function (8, 13).

Longer the duration of exposure to the dust , greater the health hazard. Nearly 10 to 15 years of exposure is necessary for the development of tissue reaction. However, there are cases on record in which extensive fibrosis has occurred within 2 years following exposure to high concentration of dust (14). Poultry farm workers exposed for more than 10 years showed widespread presence of symptoms such as persistent cough, phlegm, bronchitis and tightness of chest than those with less exposures. The pulmonary functions namely FVC, FEV_1, $FEF_{25\%}$ were significantly decreased in poultry farm workers (15). Additionally, in vitro studies on guinea pigs was done and they were exposed to poultry dust extract. The response was contraction of tracheal smooth muscle. The reason may be development of inflammatory reaction thereby releasing inflammatory cytokines such as TNF alpha and IL-1 beta (16). Marked decrease in Vital Capacity (3.1%) and Forced Expiratory Volume in one second (4.1%) was also found in shacklers exposed to poultry dust in poultry slaughter houses (17). Another cross sectional study in chicken catchers displayed a greater occurrence of chronic phlegm and wheezing. There was a decrease in FVC and FEV_1 indicating that these workers are prone to develop respiratory disease (18).

Spirometry is a physiological test that measures how an individual inhales or exhales volumes of air as a function of time. It is the most common and also a quite sensitive pulmonary function test. It has been used for a long time in many investigations, for detecting chronic work related impairment of lung function. The primary signal measured in spirometry may be volume or flow (19, 20).

Literature is available on respiratory function and poultry dust, but majority of the studies were conducted without considering the association with a long term duration-response effect between years of exposure and pulmonary function. Therefore, the objective of this study was to estimate the potential respiratory risks of workers engaged in tasks performed within poultry houses on the basis of duration of exposure. So, this study aimed to determine the effect of long term exposure to poultry dust on various pulmonary function parameters in poultry farm workers.

Aims and objectives

To record and compare the various pulmonary function

parameters in poultry farm workers on the basis of duration of exposure to poultry dust.

Methods

Study population

The study was conducted under the supervision of Department of Physiology, Dayanand Medical College & Hospital, Ludhiana, Punjab, India from December 2013 to April 2015. The institutional ethical committee for medical research in Dayanand Medical College & Hospital, Ludhiana, Punjab, India approved the study.

Source of data

The inclusion criteria were poultry farm workers between age group of 18 to 60 yrs and belonging to either gender. Smokers, subjects on medication (beta blocker, sedatives), suffering from acute or chronic cardiopulmonary disease, spine and chest deformities, who had undergone recent surgical procedures (abdominal, thoracic surgery), participating in any other study were excluded from the study.

In this study, 66 poultry farm workers were selected. All participants had given a written informed consent. The subjects of this study were chosen at random regardless of their socioeconomic status and religion so that it can show an overall picture of the lung function status of the study region. A detailed interview was conducted followed by history and clinical examination to determine whether they would be included in the study or not. Information of the poultry workers included name, age, gender, duration of work in hours per day, number of years of exposure, description of the protection equipment used during work. All participants were male workers and worked without using any personal protection equipment.

Following Anthropometric parameters were recorded :

Body height in centimetres (cms)- Subjects were made to stand without shoes in upright position (with the head in the Frankfort horizontal plane) arms at their sides, heels together, toes apart and back of the head, shoulder blades, buttocks and heels making contact with the backboard.

Body weight was measured in kilograms (kgs) by standard weighing machine.

Body mass index (BMI) in kg/m^2 was calculated by Quetelet index (21).

$$BMI = \text{Weight in kg} / (\text{Height in meters})^2$$

Spirometry

Spirometry was performed by using a computerised portable autospirometer (Helios 701: Chandigarh). The subjects were instructed to perform according to the official statement of the American Thoracic Society/ European Respiratory Society (ATS/ERS) task force guidelines (19, 20). The subjects were instructed to exhale the maximum volume of air rapidly and forcefully into the mouth piece after a deep inhalation. The whole manoeuvre was demonstrated to the subjects. The subjects were encouraged to practice this manoeuvre before doing the pulmonary function test. The test was performed with the subject in standing position using a nose clip. The test was repeated three times after adequate rest of 5 minutes to avoid exertion. Following lung parameters were obtained in the autospirometer :

1.	Forced Vital Capacity (Litres)	FVC
2.	Forced expiratory volumes over fixed time intervals (in seconds) (Litres)	$FEV_{0.5,}$ FEV_1, FEV_3
3.	Forced expiratory flow at 25% and 75% of expiration (Litres/second)	$FEF_{25-75\%}$
4.	Forced expiratory flow rate between 0.2 to 1.2 litres of volume change (Litres/second)	$FEF_{0.2-1.2}$
5.	Peak expiratory flow rate (Litres/second)	PEFR

6.	Forced expiratory flow after 25% of the FVC has been expired (Litres/second)	FEF25%
7.	Forced expiratory flow after 50% of the FVC has been expired (Litres/second)	FEF50%
8.	Forced expiratory flow after 75% of the FVC has been expired (Litres/second)	FEF75%
9.	Forced expiratory volume (timed) to forced vital capacity ratio expressed in percentage	$FEV_{O.5}$/FVC, $FEV_{1.0}$/FVC, $FEV_{3.0}$/FVC

For maximum voluntary ventilation (MVV), the subjects were instructed to breathe fast and deep for a period of fifteen seconds into the mouthpiece of the autospirometer.

Statistical Analysis

All analysis was undertaken using IBM SPSS Statistics Version 20. Mean and Standard Deviation (SD) was computed. To see the effect of duration of exposure to poultry dust on pulmonary functions, statistical analysis was done by One way ANOVA and post-hoc by Bonferroni test. The level of significance was achieved at $p<0.05$.

Results

Depending upon the duration of exposure (years) to poultry dust, poultry farm workers were divided into five subgroups (Table I).

The antropometric profile of the poultry farm workers is shown in Table II.

TABLE I: Number of poultry farm workers according to duration of exposure (years).

S.No.	*Total duration of exposure to poultry dust (years)*	*Group*	*Frequency (n)*	*Percent (%)*
1	Upto 5	A	33	50.00
2	>5-10	B	13	19.69
3	>10-15	C	07	10.60
4	>15-20	D	05	7.57
5	>20	E	08	12.12
	Total		66	100

GROUP A – upto 5 years exposure, number of workers 33 with mean age 28.24±7.628 yrs, mean weight 58.09±10.85 kgs and BMI 20.960±3.36 kg/m^2

GROUP B – >5-10 years exposure, number of workers 13 with mean age 26.31±4.73 yrs, mean weight 57.54±7.40 kgs and BMI of 21.00±2.76 kg/m^2

TABLE II: Anthropometric profile of the poultry farm workers.

	Group A (upto 5 yrs)	*Group-B (>5-10 years)*	*Group-C (>10-15 years)*	*Group-D (>15-20 years)*	*Group-E (>20years)*	*One Way Anova with Post hoc Bonferroni test. (p<0.05 statistically significant.)*
Age (yrs)	28.24±7.628	26.31±4.73	39.28±7.34	39.60±2.70	50.75±9.16	
Height (cms)	166.36±9.10	165.69±7.24	165.71±4.64	163.80±2.77	162.75±6.91	A vs B p=1.000 A vs C p=1.000 A vs D p=1.000 A vs E p=1.000
Weight (kgs)	58.09±10.85	57.54±7.40	59.60±4.98	61.62±11.51	58.71±9.61	A vs B p=1.000 A vs C p=1.000 A vs D p=1.000 A vs E p=1.000
BMI (kg/m^2)	20.960±3.36	21.00±2.76	21.81±3.15	22.21±1.69	23.11±3.32	A vs B p=1.000 A vs C p=1.000 A vs D p=1.000 A vs E p=0.868

Values expressed as Mean±SD, No significant difference in profile.

TABLE III : Comparison of pulmonary function parameters between different years of exposure to poultry dust in Poultry Workers.

Pulmonary function parameters	*Group-A (upto 5 years) n=33*	*Group-B (>5-10 years) n=13*	*Group-C (>10-15 years) n=7*	*Group-D (>15-20 years) n=5*	*Group-E (>20 years) n=8*	*Post Hoc Bonferroni test. Significant p<0.05*
FVC(L)	2.69±0.789	3.14±0.712	2.38±0.560	2.30±0.318	2.16±0.526	B vs. E p=0.030
$FEV_{0.5}$(L)	2.17±0.553	2.29±0.615	1.69±0.524	1.57±0.355	1.36±0.530	A vs. E p=0.004 B vs. E p=0.004
FEV_1(L)	2.64±0.742	2.91±0.695	2.22±0.389	2.13±0.236	1.92±0.562	B vs. E p=0.015
FEV_3(L)	2.69±0.788	3.09±0.662	2.38±0.560	2.30±0.318	2.14±0.506	B vs. E p=0.034
$FEF_{25-75\%}$(L/Sec)	4.71±1.334	4.30±1.711	3.33±0.985	3.41±1.606	2.23±0.943	A vs. E p=0.000 B vs. E p=0.013
$FEF_{0.2-1.2}$(L/Sec)	5.51±1.591	5.59±1.950	4.16±1.368	4.22±1.872	3.02±1.706	A vs. E p=0.004 B vs. E p=0.012
PEFR (L/Sec)	6.35±1.442	6.38±1.923	5.44±1.314	4.95±2.406	3.89±1.865	A vs. E p=0.004 B vs. E p=0.015
$FEF_{25\%}$(L/Sec)	6.11±1.561	5.66±2.460	4.63±1.351	4.71±2.261	3.39±1.763	A vs. E p=0.003
$FEF_{50\%}$(L/Sec)	5.09±1.456	4.72±2.077	3.62±0.907	3.68±1.543	2.46±1.090	A vs. E p=0.000 B vs. E p=0.016
$FEF_{75\%}$(L/Sec)	3.36±1.263	2.64±1.366	2.39±1.156	2.31±1.372	1.37±0.484	A vs. E p=0.001
$FEV_{0.5}$/FVC (%)	82.35±13.327	73.13±13.245	72.17±21.485	69.38±18.506	61.39±13.052	A vs. E p=0.006
FEV_1/FVC (%)	98.52±2.486	92.86±7.544	94.32±7.458	93.49±7.999	88.23±7.543	A vs. B p=0.027 A vs. E p=0.000
FEV_3/FVC(%)	100.00±0.00	98.94±3.463	100.00±0.00	100.00±0.00	99.52±1.354	B vs. E p=1.000
MVV (L/min)	105.73±24.679	109.46±33.130	88.71±18.794	79.60±10.644	73.50±33.768	A vs. E p=0.032 B vs. E p=0.038

Values are expressed as Mean±SD. One Way Anova with Post hoc Bonferroni test. $p<0.05$ statistically significant.

GROUP C – >10-15 years exposure, number of workers 7 with mean age 39.28±7.34 yrs, mean weight 59.60±4.98 kgs and BMI of 21.81±3.15 kg/m^2

GROUP D – >15-20 years exposure, number of workers 5 with mean age 39.60±2.70 yrs, mean weight 61.62±11.51 kgs and BMI of 22.21±1.69 kg/m^2

GROUP E – >20 years exposure ,number of workers 8 with mean age 50.75±9.16 yrs, mean weight 58.71±9.61 kgs and BMI of 23.11±3.32 kg/m^2

Comparison of pulmonary function parameters between different years of exposure to poultry dust in Poultry Workers is shown in Table III, Fig. 1 and 2.

Discussion

The present study was carried out in the poultry farm workers. According to the duration of exposure to poultry dust they were divided into subgroups. The anthropometric parameters namely the height, weight and BMI were found to be comparable in all the sub groups.

The present study found a duration response effect and shows that long term exposure to poultry dust prominently decreased the pulmonary functions. The authors observed that the pulmonary functions started deteriorating gradually in poultry farm workers after 5-10 years of exposure to poultry dust with maximum decrease on exposure to more than 20 years. There was statistically significant decrease in FVC, $FEV_{0.5}$, FEV_1, FEV_3 with normal FEV_1/FVC suggesting restrictive ventilatory changes in poultry workers. There was significant decrease in $FEF_{25-75\%}$ and $FEF_{0.2-1.2}$, PEFR suggesting early small and large airway obstruction respectively. A significant decrease in MVV showed increased airway resistance (22). Several studies have shown the presence of obstructive ventilatory disturbances in poultry farm workers (3, 23-25).

Alencar M, et al. also observed the presence of both restrictive and obstructive changes in poultry farm workers. They also reported that workers who were

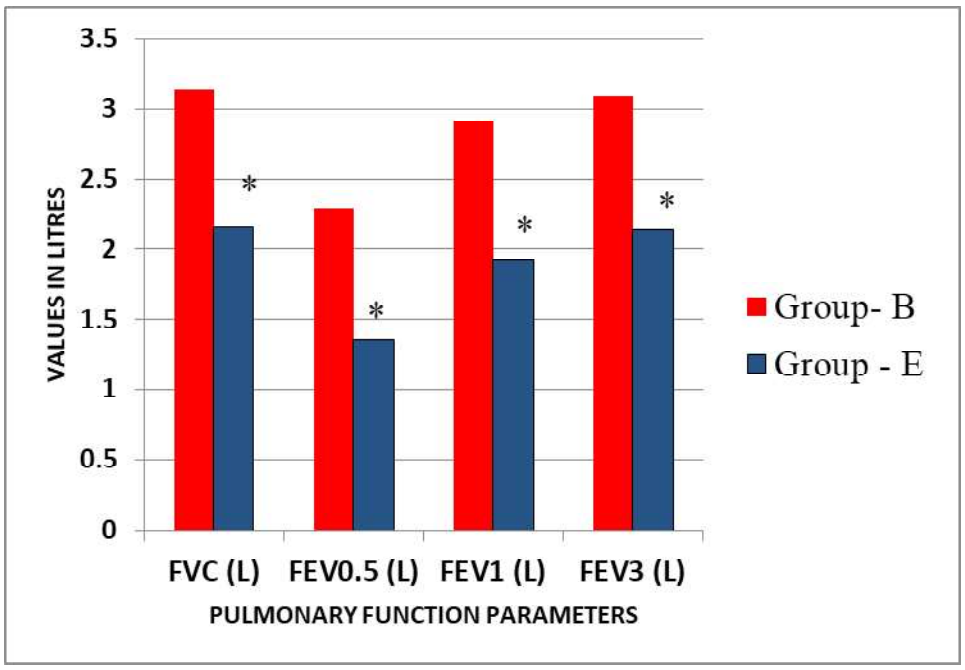

Fig. 1: Comparison of pulmonary function parameters between Group-B (>5-10 yrs) and Group-E (>20 yrs) on exposure to poultry dust. p<0.05 statistically significant.

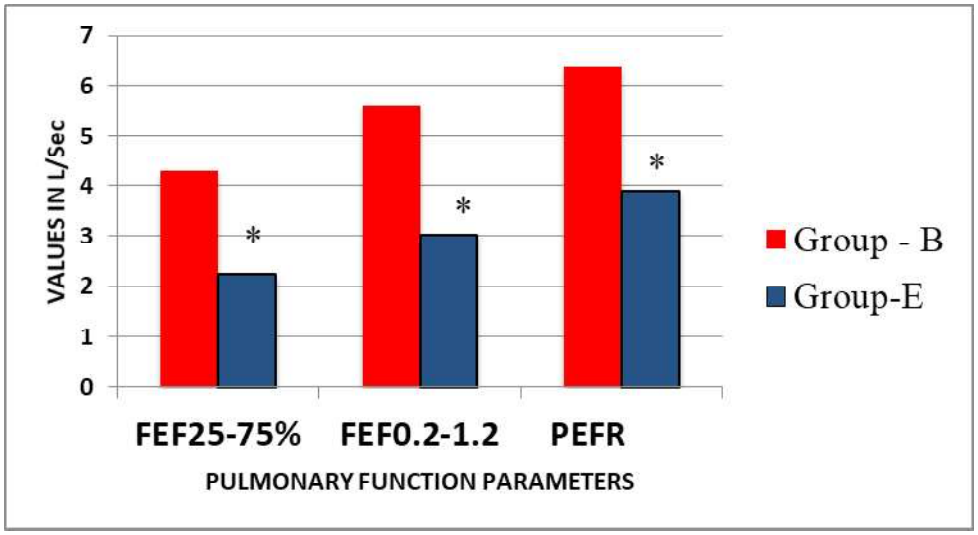

Fig. 2: Comparison of pulmonary function parameters between Group-B (>5-10 yrs) and Group-E (>20 yrs) on exposure to poultry dust. *p<0.05 statistically significant.

exposed to organic dust for more than 4 years demonstrated significantly less values of FEV_1 and FVC and these workers were at high risk when they worked more than five hours a day (26).

A study conducted in poultry farm workers in Croatia reported that poultry workers who were exposed for 10 years or more had lower respiratory capacity test results than those with short term exposures (16). In parallel to our findings, Danuser B, et al. also reported that there occurs association between the time period of exposure to poultry dust and tests results of lung

function in poultry farmers workers who work in poultry confinement houses. They found obstructive lung changes with a significant decline in FEV_1 (27). Yearly decline in pulmonary function parameters FEV_1, FVC and $FEF_{25\%-75\ \%}$ has also been observed in swine workers and grain farmers (28). Decrements in lung function values FEV_1 and $FEF_{25\%-75\%}$ has also been reported in poultry production workers over the work shift (29).

Strengths and limitations – Lung function parameters were studied in detail to see the effect of long term exposure to poultry dust. Further studies are needed with large sample size including both genders so that gender variance can also be determined. More investigations like chest–X ray can be done to confirm the findings.

Conclusion

Poultry dust adversely affects the respiratory function and this impairment is associated with duration of exposure to poultry dust. The study found a deterioration in lung function parameters with increasing exposure years suggesting a possible occupational health problem. The present study intends to raise public awareness about occupational exposure to poultry dust in poultry farm workers.

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Ethical approval

The study was approved by the institutional ethical committee for medical research in Dayanand Medical College & Hospital, Ludhiana (Punjab).

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None

Conflict of interest

None declared

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