Effect of poultry dust on pulmonary functions in poultry farm workers of India

Manpreet Kaur Taluja[1*], Vidushi Gupta[1], Garima Sharma[1], Jaspreet Singh Arora[2]

Department of Physiology, Dayanand Medical College and Hospital, Ludhiana, Punjab, India, [2]Department of Animal Biotechnology, School of Animal Biotechnology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Correspondence to: Manpreet Kaur Taluja, E-mail: drmanpreet17@gmail.com

Received: May 09, 2018; **Accepted:** May 25, 2018

ABSTRACT

Background: Individuals engaged in poultry production are exposed to varying concentrations of airborne contaminants including organic dust, gases, endotoxins, fungi, bacteria, and bacterial constituents. Long-term exposure to this environment may put the poultry workers at risk for developing respiratory dysfunction. A periodic measurement of pulmonary functions can be a guiding factor to detect pulmonary abnormalities in early stages. **Objectives:** The objectives of this study were to record and compare pulmonary function parameters in poultry farm workers and healthy controls. **Materials and Methods:** The study was conducted in 132 subjects. Pulmonary function parameters were recorded in 66 healthy volunteers and 66 poultry workers using autospirometer (Helios 701: Chandigarh). Data were analyzed using Student's *t*-test. **Results:** We found that all the pulmonary function parameters, namely, forced vital capacity (FVC), forced expiratory volume , FEV_1, and FEV_3 were significantly lower (P = 0.000) in poultry workers as compared to healthy controls, whereas FEV_1/FVC% was normal indicating restrictive type of ventilatory changes in poultry workers. There was a significant decrease (P = 0.001) in forced expiratory flow indicating early small airway obstruction and FEF 0.2–1.2 (P = 0.000) indicating large airway obstruction. A significant decrease in maximum voluntary ventilation (P = 0.000) can be due to obstructive and/or restrictive lung diseases. **Conclusion:** The results suggest that poultry workers should be made aware of hazardous effects of poultry dust, and the use of appropriate personal protective equipment during work should be implemented legally.

KEY WORDS: Poultry Production; Spirometry; Pulmonary Function Parameters; Respiratory Dysfunction; Personal Protective Equipment

INTRODUCTION

The revolution in production, processing, and marketing has characterized the growth and development of the poultry industry worldwide. During the past two decades, the production of poultry meat and eggs in the developing countries has grown faster than that of any other major food. Today, poultry industry is growing at a fast rate in India with current total poultry population being 729.21 million. Poultry meat and egg production is 3.26 tonnes and 82.93 billion, respectively.[1]

Access this article online	
Website: http://www.ijmsph.com	Quick Response code
DOI: 10.5455/ijmsph.2018.0516025052018	

The workers in poultry farm occupationally meet with significant levels of poultry dust which is composed of agricultural dust particles [11.53 mg/m^3], toxic gases, endotoxins,[2] fungi, fungal spores, bacteria and bacterial constituents, fecal material, feathers, dander, mites, pure wood dust, and dry feeds.[3,4] The primary work of poultry farm workers is to lay down bedding/litter, populate poultry houses, handle and inspect the birds, vaccinate them, routinely clean the poultry houses during the growing and production time, remove litter and manure, clean,disinfect, and fumigate the poultry sheds. All these labor works give rise to dust to which these workers are exposed.[3] The term poultry refers to all those species of birds which are reared for economic benefit and they should be able to reproduce freely under captivity. Poultry includes chickens, turkeys, ducks, quails, pheasants, geese, ostriches, quail, pigeons, and peafowls whether they are alive or dressed.[5]

The environmental dust in poultry farmhouses has been regarded as a substance hazardous to health by Control of Substances Hazardous to Health Regulations 2002.[3] Thus, the poultry dust attributes to increased probability of respiratory disorders. The higher production of gases, vapors, and fumes collectively known as high-density concentrated animal feeding operations (CAFOs) in poultry and livestock production have dangerous effect on human health as well as in the environment. The odorants such as ammonia and hydrogen sulfide emitted from CAFOs have harmful effect in these exposed poultry workers.[6]

Endotoxins exist throughout in poultry production units.[3] They are components of organic dust which have adverse effects on workers in poultry buildings.[2] In a study conducted on poultry and swine confinement workers, the endotoxin concentration (swine: average 0.12 micrograms/ m^3, poultry: average 0.31 micrograms/m^3) was within reach of causing significant adverse health effects. Concentration of microorganisms was found to be higher in these units. The reported microorganisms' concentration in the settled dust at poultry farm for bacteria and fungi was 3.2×10^8 cfu/g and 1.2×10^6 cfu/g, respectively.[7,8] Acute symptoms concerned with exposure to endotoxin included cough, tightness of chest, shortness of breath, and alterations in lung function characterized by a deterioration in forced expiratory volume (FEV_1).[9] Exposure to wood dust is associated with skin disorders, rhinitis, and occupational asthma.[3]

Thelin reported a decline in FEV_1 ranging from 0.07 to 0.19 L.[10] The decrease in average FEV_1 had also been reported by Martin *et al.* in poultry hatchery workers.[11] A study conducted in poultry confinement workers in Western Canada reported lower mean values for forced capacity (forced expiratory flow [$FEF_{25–75\%}$]) and FEV_1/forced vital capacity (FVC).[12] Morris *et al*. also reported decrements in FVC and FEV_1 values in chicken catchers.[13]

Pulmonary function tests or lung function tests estimate how efficiently the lungs take in and release air. It measures the working of the lungs.[14] A regular computation of pulmonary functions can direct the clinicians to find out the lung abnormalities at the initial stages of its development. Spirometry is simple, non-invasive, cost-effective, and the most common test done in clinical medicine and also in clinical research for detecting lung function disorders.[15] In obstructive pattern of ventilatory changes, the hallmark is decreased in expiratory flow rates. With fully established disease, the ratio FEV_1/FVC is decreased as is $FEF_{25–75\%}$.[16] It is seen in asthma, chronic obstructive pulmonary disease, bronchiectasis, and bronchiolitis.[17] In restrictive pattern of ventilatory changes, the hallmark is decrease in lung volumes but FEV_1/FVC is normal or increased.[16] It is seen in parenchymal diseases (sarcoidosis, desquamative interstitial pneumonitis, idiopathic pulmonary fibrosis, and asbestosis), neuromuscular diseases, abnormalities of chest wall, and pleura.[17]

The poultry industry being an employment intensive sector provides job to about 5 million people belonging to the weaker sections of the society.[18] This puts large population at a risk of exposure to harmful poultry dust. The cost incurred due to ill health of the poultry workers will become a big economic burden to the society.

The inhaled poultry dust particles get deposited in lung and these are removed from the lung at a very slow rate. These particles exert their effect on lung even after the exposure is stopped. Due to lack of resources and awareness at poultry farm, the preventive measures against inhalation of dust particles are generally poor. Hence, the study conducted in this area will find out the possible respiratory risk in poultry farm workers who are exposed to poultry dust within poultry houses in India. Hence, this study was designed with aims and objectives of recording and comparing the pulmonary function parameters in poultry farm workers and healthy controls as there is a dearth of literature in India among these groups of workers.

MATERIALS AND METHODS

The study was conducted in the Department of Physiology, Dayanand Medical College and Hospital, Ludhiana, Punjab, India, from December 2013 to April 2015. The study was approved by the Institutional Ethics Committee for Medical Research in Dayanand Medical College and Hospital, Ludhiana, Punjab, India.

Method of Collection of Data

The control group was taken from the general population and study group included workers in poultry farm.

Inclusion criteria

Inclusion criteria were age group between 18 and 60 years and either gender.

Exclusion criteria

Exclusion criteria were smokers, subjects on medication (beta blockers, sedatives), suffering from acute or chronic cardiopulmonary disease, spine and chest deformities, who had undergone recent surgical procedures (abdominal and thoracic surgery), and subjects participating in any other study.

Number of Cases

The study was conducted on 132 subjects. Out of 132 subjects, 66 each belonged to Groups I and II. Group I ($n = 66$) included healthy volunteers from the general population. This group served as a control group. They were matched for age and sex. Group II ($n = 66$) included poultry farm workers from Ludhiana city of Punjab (India). This served as study group. All were male poultry farm workers. There was no personal protection equipment used by the poultry farm workers.

Methodology

Volunteers were recruited as subjects to participate in the study. Subjects who fulfilled the inclusion criteria were included in the study. All the subjects participating in the study signed a written informed consent form. After examination and recording of vitals, subjects were thoroughly acquainted with the apparatus followed by explanation of the maneuvers to perform the tests according to the guidelines of the American thoracic society/European respiratory society task force guidelines.[19-21] Proper trials were given to ensure that subjects understand and become confident about the whole procedure. Then, the subjects were evaluated for various pulmonary function tests and anthropometric parameters.

Evaluation

Body height was noted by stadiometer in centimeters. 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.[22] Body weight was measured in kilograms by standard weighing machine.

Various pulmonary function parameters were recorded using spirometry with the help of a computerized portable autospirometer (Helios 701: Chandigarh). The autospirometer has a flow sensor which converts the airflow signals to digital signals. It has an inbuilt printer which gives printouts containing subject's information and calculates values of all parameters. The handset is designed in such a way that it is easy to be used by persons of all ages.

The subjects were instructed to loosen any tight clothing. All pulmonary function tests were done with the subjects in an upright position. A nose clip was attached to the subject and a clean mouthpiece was inserted into the breathing tube. It was made sure that there is no air leakage around the mouthpiece and nose clip. A total of three tests were carried out, and best of the three readings was taken into consideration for analysis.

Procedure A

Subjects were asked to inspire maximally from end-expiratory position and then place mouthpiece firmly in their mouth and were asked to expire as hard, deep, rapid, and as completely as possible into the mouthpiece.

Following parameters were recorded and calculated by autospirometer:

FVC (liters), FEVs over fixed time intervals (in seconds) expressed in liters ($FEV_{0.5}$, FEV_1, FEV_3), maximum mid expiratory flow rate (liters/second) ($FEF_{25-75\%}$), forced expiratory flow rate between 0.2 and 1.2 L of volume change (liters/second) ($FEF_{0.2-1.2}$), forced expiratory flow after 25%, 50%, and 75% of the FVC has been expired (liters/second) ($FEF_{25\%}$, $FEF_{50\%}$, and $FEF_{75\%}$), FEV (timed) to FVC ratio expressed in percentage ($FEV_{0.5}$/FVC, $FEV_{1.0}$/FVC, and $FEV_{3.0}$/FVC).

Procedure B

After rest of 5 min, subjects were asked to breathe as rapidly and deeply as possible from the mouthpiece for 15 s. This provided the measurement of maximum voluntary ventilation (MVV) in liters/minute.

Statistical Analysis

The data collected were statistically analyzed by IBM SPSS Statistics Version 20. Mean and standard deviation were computed. Student's *t*-test was applied to compare the means of control and study groups. The $P < 0.05$ was considered statistically significant.

RESULTS

The anthropometric data for poultry workers (Group II) and their matched controls (Group I) are shown in Table 1. Age and height in both exposed and unexposed group were comparable. There was statistically significant ($P = 0.000$) reduction in weight in poultry farm workers (Group- II).

Comparison of pulmonary function parameters between Groups I and II has been shown in Table 2 and Figures 1 and 2.

DISCUSSION

In the present study, it was seen that most of the lung function parameters were found to be significantly lower in poultry farm workers. FVC, $FEV_{0.5}$, FEV_1, FEV_3 $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{25-75\%}$, $FEF_{0.2-1.2}$, and MVV were significantly decreased in poultry workers.

We found that all pulmonary function parameters namely FVC, $FEV_{0.5}$, FEV_1, and FEV_3 were statistically significantly

Table 1: Anthropometric data of subjects in Groups-I and II

Demographic profile	Mean±SD		*P*
	Controls (Group-I) (*n*=66)	Study group (Group-II) (*n*=66)	
Age (years)	30.62±11.331	32.62±10.674	0.299
Height (cm)	167.33±7.943	165.53±7.638	0.186
Weight (kg)	71.47±13.178	58.71±9.609*	0.000

SD: Standard deviation, *n*: Number of subjects, **P*<0.05 taken as statistically significant

Table 2: Comparison of pulmonary function parameters between subjects in Groups-I and II

Pulmonary parameters	Mean±SD		*P*
	Controls (Group-I) (*n*=66)	Study group (Group-II) (*n*=66)	
FVC (L)	3.39±0.665	2.65±0.749*	0.000
$FEV_{0.5}$ (L)	2.63±0.537	1.20±0.625*	0.000
FEV_1 (L)	3.21±0.657	2.53±0.718*	0.000
FEV_3 (L)	3.36±0.660	2.64±0.734*	0.000
$FEF_{25-75\%}$ (L/s)	5.02±1.490	4.09±1.580*	0.001
$FEF_{0.2-1.2}$(L/s)	7.23±1.806	4.98±1.850*	0.000
$FEF_{25\%}$ (L/s)	7.47±1.820	5.43±2.002*	0.000
$FEF_{50\%}$ (L/s)	5.55±1.630	4.44±1.738*	0.000
$FEF_{75\%}$ (L/s)	3.13±1.385	2.80±1.359	0.158
$FEV_{0.5}$/FVC%	78.00±8.884	75.93±15.976	0.361
FEV_1/FVC%	94.87±5.038	95.33±6.462	0.648
FEV_3/FVC%	99.27±1.927	99.73±1.610	0.137
MVV (L/min)	127.30±26.590	98.77±28.810*	0.000

SD: Standard deviation, *n*: Number of subjects, **P*<0.05 taken as statistically significant. FVC: Forced vital capacity, FEV: Forced expiratory volume, FEF: Forced expiratory flow

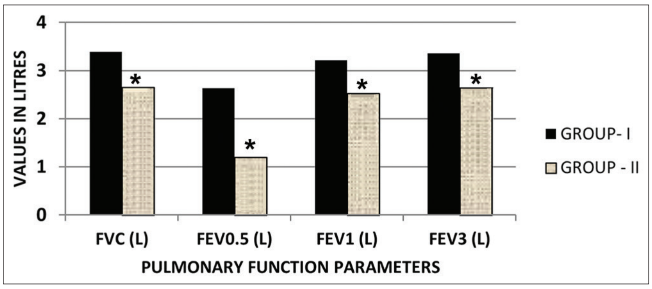

Figure 1: Comparison of pulmonary function parameters between subjects in Groups-I and II.**P*<0.05 taken as statistically significant

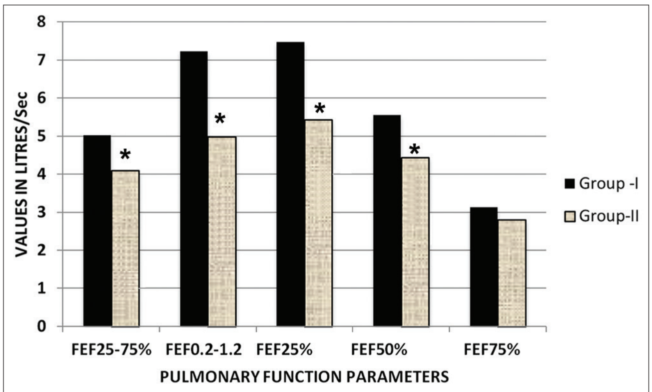

Figure 2: Comparison of pulmonary function parameters between subjects in Groups-I and II.**P*<0.05 taken as statistically significant

lower (*P* = 0.000) in poultry farm workers when compared to healthy controls whereas FEV_1/FVC was normal indicating the restrictive type of ventilatory changes in poultry workers. Our results are similar to the results obtained by Alencar M do CB de *et al*., who reported significantly lower values of FEV_1 and FVC than predicted and normal FEV_1/FVC in workers of poultry house.[4,16] The FEV_1 values of the exposed employees in poultry were decreased significantly as compared to the normal values.[10,23,24] Decrease in FEV_1 may be due to the effect of endotoxins,[9] mycotoxins, beta glucans,[3] and ammonia[24] present in the poultry dust.

In our study, there was statistically significant decrease (*P* = 0.000) in $FEF_{25\%}$ and $FEF_{50\%}$ indicating obstructive changes. Zuskin *et al*. observed that there was a significant decline in FVC, FEV_1, and $FEF_{25\%}$ in poultry farm workers.[25] There was statistically significant decrease (*P* = 0.001) in $FEF_{25-75\%}$ indicating early small airway obstruction. Decrease in $FEF_{25-75\%}$ can be only abnormality in early small airway obstruction with normal FEV_1/FVC.[16] Lower mean values of FEV_1,$FEF_{25-75\%}$, and FEV_1/FVC had also been reported in various studies on poultry workers.[4,12] The poultry workers in the present study showed statistically significant decrease in $FEF_{0.2-1.2}$ (*P* = 0.000) indicating large airway obstruction as reported by Balmes and Speizer.[26] There was statistically significant decrease ($P = 0.000$) in MVV in poultry farm workers in our study as compared to controls. A lower value of MVV is more experienced in restrictive lung disease, but it can be obtained in obstructive condition as well.[27] Furthermore, it is non-specific, as it is affected by other factors such as muscle strength and endurance, motivation, and sensorium.[28]

Strength and Limitations

We have assessed the effect of poultry dust on all pulmonary function parameters in poultry farm workers for which very few studies have been conducted so far in India. However, measurements of environment in terms of concentration of total dust, endotoxins, microorganisms, and gases along with temperature and relative humidity inside the poultry farms could have contributed to more precise effects on lung functions.

CONCLUSION

The present study concluded that poultry farm workers are at risk for lung function impairment. Awareness should be spread to poultry workers about the health risks due to exposure to poultry dust in poultry workers. The use of personal protective equipment during work should be implemented legally along with regular health checkups.

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How to cite this article: Taluja MK, Gupta V, Sharma G, Arora JS. Effect of poultry dust on pulmonary functions in poultry farm workers of India. Int J Med Sci Public Health 2018;7(9):719-724.

Source of Support: Nil, **Conflict of Interest:** None declared.